US Army Corps of Engineers
Portland District

EPA

2008 Annual Use Plan
Management of Open Water Dredged Material Disposal Sites
Mouth of the Columbia River, OR and WA

1. Purpose

The year-to-year management of open water dredged material disposal sites located at the mouth of the Columbia River (MCR) is controlled and documented through the preparation and adherence to an Annual Use Plan. This Annual Use Plan (AUP) serves as the primary mechanism for evaluating disposal site capacity and managing dredged material placement. The AUP is revised for each dredging and disposal season, as required by disposal site designation [USEPA 2005]. It is prepared by USACE and reviewed and approved by USEPA, Region 10.

This document is the 2008 AUP for utilizing ocean dredged material disposal sites (ODMDS) located offshore the mouth of the Columbia River. Only dredged material determined to be suitable for unconfined in-water disposal, through application of the current Sediment Evaluation Framework (SEF) for the Pacific Northwest region, may be placed at the sites described within this AUP. The total volume of dredged material to be placed within MCR disposal sites during 2008 is expected to be 3-4.5 million cubic yards (MCY). During 2008, the dredged material that is to be placed within available MCR disposal sites will originate from the MCR federal navigation channel.

2. Background

Each year, the Corps of Engineers-Portland District dredges 3-5 MCY of sand at the mouth of the Columbia River (MCR) to maintain the inlet's 6-mile long deep draft navigation channel (figure 1). Most of the dredging occurs between river mile –2.0 and +2.5. The dredged material is fine-medium sand (0.19-0.25 mm) and fine-grained material (passing a 230 mesh sieve) content is 3% or less. The dredged sand is placed at two EPA designated ODMDS [USEPA 2005], or at sites available under Section 404 of the Clean Water Act (404 site). Due to the exposed ocean conditions at MCR, only ocean-going hopper dredges can perform dredging and disposal at MCR. Dredging is limited to June-November when wave conditions are favorable for working on the bar. Refer to Appendix A for additional information describing the MCR navigation project, dredged material disposal sites, and hopper dredge operating characteristics. Appendix B summarizes the use of MCR disposal site during 2007 in context to the bathymetry changes that have occurred during 1997-2008. The term "bathymetry" refers to topography of the seabed. Appendix B also summarizes special studies conducted during 2007, associated with MCR-ODMDS use and potential impacts.

During 2008, there is no dredged material from the Columbia River and Lower Willamette (C&LW) project expected to be placed within the ocean disposal sites at the

MCR. Refer to Appendix A for additional information describing the C&LW navigation project.

Available MCR Disposal Sites. MCR open water dredged material disposal sites available for use during 2008 are shown in figure 1 and 1a. As designated by USEPA-Region 10 in 2005, the Shallow Water Site (SWS) and Deep Water Site (DWS) can be used for the disposal of material dredged from either the MCR or the LCR. The North Jetty Site (NJS) is limited to MCR dredged material disposal. The SWS is of strategic importance to the region; its continual use has supplemented Peacock Spit with 75 million cy since 1973 (27 MCY since 1997). Use of the SWS (formally site E) has maintained the littoral sediment budget north of MCR, protected the north jetty from scour and wave attack, and stabilized the MCR inlet. Figure 27 and 33-34 shows the recent bathymetry change of Peacock Spit in context of the SWS (green is erosion and red is deposition). Had the SWS not been used during 1997-2007, much of Peacock Spit would have lost significantly more sediment than is presently the case. It is USACE's position that the SWS must continue to be used to maintain the MCR inlet and stabilize the sediment budget north of the MCR [Moritz et al 2007]. Use of the NJS protects the toe of the north jetty from excessive wave and current scour. The beneficial uses of dredged material placed at the nearshore sites (SWS and NJS) are preferred before dredged material is allocated to the DWS [USEPA 2005 and USACE/USEPA 1999, 2003, and 2005]. Priority will be given to utilize the available capacity of the nearshore sites to the fullest extent possible.

To control the long-term accumulation (mounding) of dredged material placed within the DWS and limit the areal deposition of material placed within the site, specific drop zones will be assigned within the DWS to direct the placement of dredged material, depending upon the material volume and origination. The MCR-07-DWS drop zone will be used for the disposal of MCR dredged material which can not be placed within nearshore sites. Note that the area within the DWS available for 2008 placement of MCR dredged material was first used in 2007. The drop zone was relocated in 2007 from the area previously used during 2005-2006 (see figure 1). This DWS drop zone modification was needed to limit dredged material mounding within DWS, as specified in the (SMMP) Site Management and Monitoring Plan [EPA 2005]. Refer to Appendix A for additional information describing MCR dredged material disposal sites.

Due to safety restrictions at the SWS and NJS (which limits access to SWS and NJS to one dredge at a time), it may be necessary to intermittently use the DWS before the capacity of either the SWS or NJS is fully used (when two dredges would otherwise attempt simultaneous disposal within the SWS or NJS). Limiting the use of the SWS and NJS to one dredge also reduces the likelihood of mounding within each site (overloading of the site's capacity to disperse placed dredged material). Utilization of MCR disposal sites will be coordinated to minimize use of the DWS, while capacity still remains within the SWS or NJ Site.

Management of an open water disposal site is predicated on the need to efficiently utilize the site's capacity while minimizing impacts to navigation and offsite environment and meeting statutory requirements. The capacity of an open water dredged material disposal site is defined by the volume (or height and area) of dredged material that can accumulate within a site's boundaries without unacceptable impacts to navigation or the environment. The potential for dredged material accumulation to have an effect upon waves (mound-induced wave shoaling) is an important site management consideration at MCR [USEPA 2005, USACE 2005 & 2003, and USACE 2008].

2008 Dredging Year. Figure 1a shows the general location from which sediment is to be dredged from the MCR channel (between RM –2 and 2.5) during 2008. Based on an April 2008 survey of the MCR, the total volume of dredged material to be placed within MCR disposal sites during 2008 is expected to be 4 MCY. The USACE and USEPA have assigned a target capacity for each disposal site to be used during the 2008 dredging season. General utilization procedures and constraints for each disposal site are described in Appendix A. During 2008, two hopper dredges will be used to perform maintenance dredging at MCR: A government operated dredge (*Essayons*) and a contractor operated dredge (*Terrapin Island*), each with different capacities and operating characteristics. The *Essayons* is currently being repowered, and is scheduled to be out of drydock and dredging at MCR in August 2008. The *Terrapin Island* is expected to begin dredging at MCR in late June 2008. During 15 July – 30 Sept, approximately 125 KCY of MCR dredged material is to be placed at the NJ Berm Site, an upland location adjacent to the MCR north jetty. This activity is required to protect the root of the north jetty from breaching during storm wave and surge action. The dredged material will be pumped ashore by the *Terrapin Island* in a manner similar to the 2002 pump ashore operation. Refer to Appendix A for details.

Available Disposal Site Capacity. Bathymetry surveys were obtained during April 2008, for the SWS and the NJ Site, to assess the present capacity of these disposal sites and to support the preparation of this AUP. The present capacity estimate for the MCR-07-DWS is based on an August 2005 survey (2007 was the first year that this area of the DWS had been used). The SWS and NJ may be surveyed again June 2008 to improve planning for disposal site utilization during 2008, immediately prior to dredging/disposal operations. Immediately prior to commencing 2008 dredging, a pre-disposal survey will be obtained for the MCR channel to better quantify the volume and location of material to be dredged.

As of 1 April 2008, the target (static) capacity of the SWS and NJ site was estimated to be 2.2 MCY and 0.2 MCY, respectively. A "static" capacity estimate ***assumes*** that the SWS and the NJ site will experience NO sediment dispersion (transport of sediment out of each disposal site) during the 2008 dredging season. Because 20-50% of the dredged material placed in each site during the dredging season is transported out of each respective site (Table B2), it is anticipated that the 2008 disposal capacity actually realized for the SWS and NJS will exceed the present estimate.

Based on the present target capacity estimates for SWS and NJS, the total MCR dredging requirement for 2008 (4 MCY, est.) is expected to exceed the present combined capacity of the SWS and NJ site by no more than 1.6 MCY. As noted above, the capacity of the

SWS and the NJ site will be fully utilized throughout the 2007 dredging-disposal, to minimize the volume of material placed within the DWS. MCR dredged material that can not be placed within the nearshore sites, will be placed within the DWS (drop zone MCR-07-DWS). The present capacity of the MCR-07-DWS is estimated to be 10-12 MCY, which is sufficient to handle the disposal needs at MCR for 6-10 years out.

<u>Timing of Site Use.</u> The *contract* hopper dredge (*Terrapin Island*), is expected to dredge a minimum of 2.0 MCY from the MCR channel; with contract options for an additional 1 MCY if needed. The *Terrapin Island* will begin dredging-disposal operation in late June and continue (intermittently) though September. Based on present contract options and provisional capacity estimates for the SWS and NJ site, the contract hopper dredge may be able to place up to 2.0 MCY in the SWS, up to 0.2 MCY in the NJ site, and up to 0.8 MCY in MCR-07-DWS. The NJ site will not be used after 1 October. The contract hopper dredge may use the SWS and NJS in a concurrent manner, before utilizing the DWS.

The government dredge (*Essayons)* is expected to dredge up to 1.5 MCY from the MCR channel, and will begin utilizing MCR disposal sites in late August and continue intermittently though October. Based on the provisional capacity estimates for the SWS and NJ site, the *Essayons* may be limited to placing less than 1.0 MCY in the SWS, and up to 1.5 MCY in MCR-07-DWS. The government hopper dredge will likely use the SWS and DWS in a concurrent manner.

To improve capacity utilization within the SWS during 2008, the SWS may not be used during periods of 1-2 weeks to allow waves and currents to “disperse” recently placed dredged material out of the site. If needed, other sites (DWS and NJ Site) may be used concurrently with the SWS to avoid overloading the SWS and extend the time for which the SWS can be used (increase the capacity of the SWS).

3. Annual Use Plan Objective

The objective of this *Annual Use Plan* for 2008 is to: A) Provide a decision framework that allows MCR dredging operations managers to manage open water disposal sites on a day to day basis , and B) Define a strategy to collect information (via monitoring or assessment of operational data) on a frequent basis, so that potential problems can be identified and corrective action can be undertaken.

The amount of dredged material that can be placed in an open water disposal site is limited by the site’s <u>capacity</u> to disperse or accumulate the material without adversely affecting the environment or navigation. ***The principal site management constraint for MCR is to avoid modification of a disposal site’s bathymetry (via dredged material mounding) that could potentially result in excessive wave amplification, due to wave shoaling over mounded dredged material.*** This AUP was developed to meet the requirement of the MCR ODMDS Site Management & Monitoring Plan [USEPA/USACE 2005]. As proposed, this *Annual Use Plan* is in place for the 2008 dredging season only. Elements of this annual use plan will be modified during the dredging season in accordance with adaptive site management.

The 2008 *Annual Use Plan* describes how each available MCR dredged material disposal site will be used and monitored. Two methods will be employed to monitor the placement of dredged material within each disposal site during 2008 and prevent mounding beyond the management target. The first monitoring method focuses on tracking the placement of dredged material within each disposal site on a daily basis, by plotting the location (dump track line) of each load placed. Frequent plotting of disposal locations will provide a continuous knowledge base of how placed dredged material is being deposited within a given site. During 2003-2007 daily tracking of hopper dredges (during dredged material disposal) significantly enhanced the management of dredged material disposal site capacity [USACE 2004]. The second monitoring method involves conducting frequent bathymetry surveys at active MCR disposal sites during the dredging season. Comparison of surveys to a site's baseline condition will quantify deposition of dredged material placed within a given site. Timely use of this information can be used to manage dredged material accumulation within a given disposal site.

The 2008 *Annual Use Plan* is based on adaptive management. This means that MCR disposal sites will be proactively managed: As sites are used, they are monitored to verify that the sites are being managed according to 2008 capacity targets. If a given disposal site is at or near its target capacity, then site management changes accordingly. The *Annual Use Plan* implements various recommendations made by a "*Federal Review Team*" [USACE/USEPA 2001] which was convened in September 2001 for the purpose of reviewing management practices at MCR dredged material disposal sites.

4. Site Management Criteria

The level to which any site can be used for dredged material disposal is related to the capacity available within the site and the efficiency to which the site's capacity is used. This means that the dredged material would be distributed throughout the entire site, both in space and time. Placement will use a regimented procedure to produce a uniform continuous deposition layer on the seabed, to avoid the formation of any localized mounding. Geometrically, the target capacity for a given disposal site is defined by the target <u>height</u> and <u>area</u> over which dredged material can accumulate (collectively referred to as a "target accumulation"), with respect to a baseline condition. The target capacity for a given disposal site defines a management condition for which an intermediate review action (decision point) occurs. At this point, the potential cumulative effects of additional disposal site utilization are assessed in conjunction with other physical processes. Use of an active disposal area may be discontinued upon reaching the specified target accumulation. The target accumulation is based on the need to manage dredged material accumulation such that mounded dredged material does not excessively amplify waves due to shoaling and refraction. The target accumulation may be different for each disposal site.

Target values for managing the accumulation of dredged material were obtained using the RCPWAVE model [Ebersole 1986] as discussed in USACE [1999, 2001, and 2002]. RCPWAVE is a numerical model that simulates the behavior of waves as they interact with spatially variable bathymetry (underwater mounds in this case). It must be noted that wave height results obtained using RCPWAVE can be 10-50% higher than the actual case: RCPWAVE overestimates how waves interact with variable bathymetry (the model is conservative). The target mound heights given in table 1 are conservative and are intended to provide a safe operational limit to define an intermediate review action for site management.

A detailed analysis of various scenarios for dredged material placement (deposition and related wave effects) within the SWS was conducted by USEPA in 2003. The analysis concluded that the *target mound height* for dredged material accumulation, (the value presently being used for site management), is 2-3 ft below the level that would begin to affect waves passing over the SWS. The difference between the *target mound height* and the mound height that would actually begin to affect waves over the SWS, translates into a disposal volume of 1-2 MCY. This is the marginal capacity of the SWS that is not being realized in order to manage the site at a very safe operational limit. A supplemental wave analysis was recently completed to investigate the behavior of wind-wave and swell associated with the present (Fall 2007) nearshore bathymetry condition at the Mouth of the Columbia River. Results were compared to those applicable to the 1997 bathymetry condition, to assess the potential changes in the wave environment due to bathymetry change. Results of the recent wave analysis are summarized in Appendix B.

Table 1 presents the target mound heights applicable for MCR disposal sites and Appendix A discusses site specific details concerning target mound heights, site utilization, and present disposal site capacity. Because of the need to assign capacity and concern for navigation safety, thresholds for increasing the level of monitoring intensity and management responses have been identified (see Section 5). The "target mound height" values shown in table 1 are intended to be used only as an ODMDS management guide (a screening tool to identify site management thresholds for concern). Dredged material disposal events that produce total accumulation levels less than or equal to the "target mound height" throughout the site are acceptable. (Note: the values shown in Table 1 apply to a mound feature that occupies an area of 2,000 x 2,000 ft). Little or no wave amplification would be expected for smaller mound features that are equal to or marginally higher than the "target mound height" values in Table 1 [USACE 2002]. As dredged material accumulation approaches the "target mound height", efforts are enacted to minimize additional dredged material accumulation within the affected area (dredged material would be placed uniformly within other areas of the disposal site).

The target mound height corresponding to the **"present"** site condition (April 2008 for the SWS) applies to the utilization of available disposal, sites at the beginning of the 2008 dredging-disposal season. The "present" target mound height will be redefined throughout the 2008 dredging-disposal season based on subsequent bathymetry surveys. Note that the bathymetry at several areas within a given disposal site will change since the establishment of the sites' baseline condition. For example, the eastern area of the SWS is now deeper than it was in 1997 (baseline condition) while the western area of the site is shallower than in 1997 (see Appendix A and B). The "present" target mound heights shown in table 1 account for the change in site bathymetry that have occurred since the baseline condition.

Active disposal sites are monitored throughout the dredging disposal season to ascertain the level of mounding within each site and the corresponding management "action level" (see Section 5). Concern associated with dredged material mounding within a given disposal site, should arise only if the level of accumulation significantly exceeds the target height and/or the area of accumulation exceeding the target value becomes greater than 2,000 x 2,000 ft. Detailed examination of wave amplification potential will be conducted if dredged material accumulates to levels that substantially exceed the "target mound height" and/or covers an area larger than 2,000 x 2,000 feet. Should this occur, the STWAVE model [Smith 2001] will be used to assess whether the area of accumulation may potentially affect waves in or near the disposal site. Although RCPWAVE is considered an appropriate model for establishing conservative target mound heights, STWAVE is more accurate and considered to be better suited for predicting actual conditions (see Appendix A).

Table 1. Target height of dredged material mounds, based on the RCPWAVE model. Values to be used for intermediate review of disposal site capacity.

Disposal Site	Target Mound Height (ft) with respect to Baseline	Target Mound Height (ft) with respect to **Present**	Drop Zone Area (acre)	Present Site Static Capacity Volume (CY)
SWS – East	5	**5**	190	**1.2 M**
SWS – West	5	**3**	100	**1.0 M**
NJ Site*	8	**2**	100	**0.2 M**
DWS – MCR	40	**30**	360	**10.0 M**

SWS = designated under section 102 of MPRSA, 1 April 2005 (40CFR, Part 228), formally ODMDS E
DWS = designated under section 102 of MPRSA, 1 April 2005 (40CFR, Part 228)
* = The NJ is not subject to the same target mound geometry criteria as unprotected sites. For initial assessment of 2005 dredging-disposal season, capacity of Site NJ has been set at 0.20 MCY to minimize potential transport to areas near the MCR channel.
Baseline = 1997 for SWS, 1999 for NJ Site, 2005 for MCR-DWS

5. Decision Framework for Site Threshold Management

Based on the above site management criteria, there are 6 action levels that will be used for managing dredged material placement within disposal sites at MCR.

Level 1. **Normal Level** = Dredged material accumulation is not close to the accumulation target. ACTION: Proceed as planned.
Level 2. **Limited Capacity Level** = Dredged material accumulates to within 1-2 ft of the threshold mound height in some part of the drop zone. ACTION: Minimize placement in affected location.

Level 3. **Threshold Level** = Dredged material accumulates to (or marginally exceeds) the target mound height within localized extent (less than 500 x 500 ft). ACTION: Assess accumulation in surrounding cells and overall site capacity. Avoid or minimize placement in the affected location of accumulation. Continue to use adjacent areas within site appropriately.
Level 4. **Limited Management Level** = Dredged material exceeds target mound height by 1-2 ft over an area greater than 500 x 500 ft. ACTION: Assess accumulation in surrounding cells and overall site capacity. Avoid or minimize placement in the affected location of accumulation and in adjacent areas. Continue to use areas not affected; adopt early exit strategy for site.
Level 5. **Moderate Management Level** = Dredged material exceeds target mound height by more than 2 ft over an area greater than 1,000 x 1,000 ft. ACTION: Assess accumulation in surrounding cells and overall site capacity. Stop using the area of the site exhibiting accumulation, until natural erosion has reduced accumulation (restored site capacity).
Level 6. **General Management Level** = Dredged material exceeds target mound height by more than 2 ft over an area greater than 2,000 x 2,000 ft. ACTION: Assess accumulation in surrounding cells and overall site capacity. Stop using the area of the site exhibiting accumulation. Assess potential wave impacts using STWAVE and determine appropriate action based on results.

6. Disposal Site Management Strategy

The goal of managing MCR disposal sites, particularly the SWS and NJ Site, is to fully utilize each available site, while limiting the average vertical accumulation of placed dredged material so as to minimize the potential for adversely affecting wave conditions at or near the site. To successfully manage each site throughout the dredging season, the capacity of each site must be frequently assessed.

As a general rule, capacity assessment for an *active* disposal site (one that is being used) will occur based upon the frequency at which a given site's bathymetry is surveyed. The frequency of conducting surveys will be directly related to the rate at which dredged material is placed within a given site. In this regard, the frequency for assessing active disposal sites will be based on the rate of volume of dredged material placed within the site. The Portland District (OP-NW and EC-CR) will, on a daily basis, collect operational dredging/disposal data at MCR (specifically, dump tracklines and beginning-ending coordinates). The data will be transferred to EC-HY/HR for compilation and plotting. Figure 2 shows the flow diagram describing the procedure of processing monitoring data and using the processed data to manage disposal site capacity. Improvements to the disposal plan will be identified and initiated within 1-2 days as necessary.

Coordination meetings will be conducted among different Portland District offices and EPA to discuss dredging and disposal management. Periodically, Portland District (OP-NW) will prepare a report that summarizes the volume of dredged material placed, relate this data to the changes in capacity for active MCR disposal sites, and make recommendations for utilizing each site. Active dredged material disposal sites will be assessed according to the management thresholds listed in Section 5 "Decision

Framework for Site Threshold Management" and coordinated with EPA-Region 10. Periodically during the dredging season updates will be furnished via email to EPA-Region 10 and the members of the MCR Update Distribution List maintained by the MCR Channel O&M project manager (OP-NW).

Use of an active disposal site (or portion thereof) may be temporarily discontinued based on management indicators that show the potential for exceeding the target accumulation within the site, the status or location of the dredges and hydrosurvey vessels, priority use of sites, or other site use constraints. Weekly recommendations may address revision of monitoring needs (i.e. site bathymetry surveys) or the collection of additional operational data to be used for the purpose of improving the assessment of disposal site capacity. Data required to monitor the progress of site utilization includes: bathymetry surveys; analysis of surveys (plotting, differencing, or other processing); tracking of disposal locations within each site; and other pertinent information provided by the dredge operators. See figure 2 for the flow diagram describing the work elements for monitoring and managing disposal site capacity.

Within the collective constraints of available MCR disposal sites, preference is given to using the Shallow Water Site (SWS) and the North Jetty (NJ) site. However, based on surveys conducted during April 2008, the SWS and the NJ site do not have sufficient capacity to meet the requirements for all MCR dredged material disposal during 2008. The Deep Water Site (DWS) will be used to supplement disposal site capacity for MCR dredging requirement during 2008 (refer to Section 8, fourth paragraph). It is intended that the contract dredge place up to 2.0 MCY of MCR material in SWS, up to 0.2 MCY of MCR material in the NJ site, and up to 0.8 MCY in the DWS (MCR-07-DWS drop zone). The government dredge is expected to place up to 1 MCY of MCR material in the SWS and up to 1.5 MCY in the DWS (MCR-07-DWS drop zone). Subsequent surveys of the SWS and NJ Site (during 2008) may show increased erosion within these areas, which may result in additional nearshore capacity for dredged material disposal. This would effectively reduce the volume of MCR dredged material that would be placed at the DWS (MCR-07-DWS).

If the SWS is to be used by both the government and contract hopper dredges for the disposal of MCR dredged material and does not have the capacity to allow both dredges to complete their respective MCR requirement, then both dredges may need to use the MCR-07-DWS.

The SWS requires focused monitoring during dredged material placement to ensure that the site is fully utilized without exceeding the site's management target. The SWS will be managed such that the site may be under-utilized, rather than attempting to achieve full utilization of the site at the risk of exceeding the site's capacity constraints. During 2005-2007, concurrent use of the NJ site, DWS, and SWS, reduced the rate at which material was placed within the SWS, yet allowed the site to fully disperse the material being placed within it. The cessation of SWS use during 2-week to 1-month periods gave the SWS a "holiday" to further disperse placed material (figure 16). More material was placed in the SWS throughout the 2005 - 2007 seasons by not over-using the site during a short time period. Intermittent use of the SWS had increased the dispersive capacity of the site (see Appendix B). Figures 3a-b show the flow diagram describing the procedure for assessing site capacity and directing the government and contractor dredges to specific MCR disposal sites.

A primary objective of this AUP is to leave the areas of the SWS, NJS, and DWS utilized during 2008 in a post-disposal condition which does not degrade navigation conditions or adversely affect other uses of the ocean within or adjacent to each disposal site.

7. Site Management and Monitoring – Routine and Special Studies

Monitoring of active ODMDSs at MCR is required based on the site designation statute of MPRSA. Both management and monitoring are described in the 2005 USEPA/USACE Site Management/Monitoring Plan (SMMP) for the Mouth of the Columbia River. Monitoring as described in the SMMP includes routine monitoring and when triggered special studies. Typically routine annual monitoring consists of bathymetric surveys of both the SWS and DWS. The intensity of these surveys is greater for the SWS than the DWS. For the DWS these would consist of a pre/post disposal survey of those areas proposed for placement of dredged material as well those portions of the site used the previous year. Placement of >500,000 CY at the DWS would trigger sediment physical characterization.

At the conclusion of the dredging season, USACE-USEPA will prepare a yearly report summarizing utilization of active MCR disposal sites (similar in scope to the first part of Appendix B and related figures). This report will be made available to MCR stakeholders and resource agencies within 3 months of the end of the dredging season. Appendix B features results from the post 2007 disposal assessment.

At the conclusion of the 2007 dredging disposal season, USACE applied the STWAVE model to assess the post disposal bathymetry of the SWS and Peacock Spit for wave amplification due to dredged material mounding within the SWS and regional bathymetry changes of Peacock Spit (figure 34). Wave amplification was assessed with respect to the bathymetry changes that have occurred with respect to the SWS baseline condition (1997). The wave analysis included a characterization of the wave conditions that may pose navigation hazards. Post-2007 disposal season bathymetry surveys were used to describe the condition of Peacock at the conclusion of the dredging season. This survey was merged with other 2007 MCR surveys to describe the overall region of MCR for the purpose of assessing potential post-disposal wave amplification associated with utilization of the SWS and Peacock Spit bathymetry changes. Refer to Appendix B for additional details.

Special studies are non-routine studies of specified duration that are intended to address specific questions or issues that are not covered by routine monitoring or that arise from questions or issues identified through routine monitoring. Designation of the SWS and DWS by USEPA in 2005, required additional disposal site monitoring/studies to be completed within 3 years of designation. These additional monitoring actions included biological as well as physical special studies. Proposals for ODMDS monitoring and special studies were submitted to EPA, Region 10 for review and approval. Special studies for 2005 included sediment profile imaging, benthic infauna and physical sediment analysis, bottom trawls, detailed bathymetry surveys, modeling, and crab pot deployment. Sampling protocols were similar to those applied in 2002 for the DWS Biological Baseline survey but focused on the area of the 2005 placement with suitable reference areas. Results of the physical, biological, and numerical modeling analyses conducted during 2005 were summarized in the 2006 AUP. All special studies required by the EPA in 2005 have been completed.

The ARGUS beach monitoring system (ABMS) at North Head has been operational since 2004 and is used to verify that wave action on Peacock Spit is not negatively affected by the SWS (http://www.planetargus.com/north_head). Additional monitoring and physical analysis of the DWS is required when more than 0.5 MCY of dredged material is placed within the DWS during a given year, or at the end of 10 years after designation regardless of level of use. A summary of the recent studies conducted in support of the federal navigation project and related environmental assessment at MCR can be found in http://www.nwp.usace.army.mil/op/n/projects/mcr/present.asp

Several monitoring and modeling activities for the SWS and DWS were conducted during 2007, to build on and complement the work performed in 2006 and prior years. An assessment of the post-2007 disposal season wave conditions at MCR and the SWS was completed in early 2008. A sediment tracer study which was initiated in September 2006 was completed in Nov 2007. Results of these studies are summarized in Appendix B of this AUP.

8. Survey Frequency for Monitoring Dredged Material Accumulation

Minimum site monitoring requirements for each active disposal site at MCR are a pre-disposal bathymetry survey (beginning of season), post-disposal survey (end of season) and a 2 x 2 mile area on Peacock Spit. Refer to figure 4 for survey coverage at MCR. Present operational strategy requires that the SWS and the NJ Site be surveyed at least once a month during the 2008 MCR dredging season. The drop zones of the DWS used during 2008 will be surveyed at the end of the dredging/disposal season, weather permitting. For active disposal sites, the survey frequency may differ from the minimum requirements, as specified in Table 2.

For all sites that are actually being used, an alternative Frequency for Site Monitoring (FSM) will be based on: The volumetric rate ($\forall$) at which dredged material is begin placed, the area (A) over which the dredged material is being placed, and the vertical target (H) for dredged material accumulation. It is noted that as a given site (or portion thereof) is "filled" with dredged material, H will change (become less with time). The FSM may need to increase as a site is being filled. FSM will be re-assessed each time an active site is surveyed. An entire disposal area need not be surveyed during each survey; only the parts of the site receiving dredged material and adjacent areas (within approximately 1,000 ft of disposal activity). If the FSM becomes too frequent, then the disposal area may be considered “filled” and not used until sufficient dredged material dispersion occurs (as determined by site monitoring).

Equation 1 was used to estimate survey frequency for each site. Note that FSM (equation 1) assumes: The survey will be conducted at the midpoint of a site’s total remaining capacity; dredged material is continuously placed at the site; and 20% of the site’s area is not used. Table 2 specifies the initial FSM for each site based on initial conditions for 2004 and other parameters as shown. Note that the FSMs in table 2 will require revision as the capacity (allowable accumulation height) of each site is reduced by dredged material disposal.

Frequency of Site Monitoring (FSM)
= (Target Height/2) x (Site Area*0.8/∀olume placed per day) [Equation 1]

Example: Initial FSM for the ***Eastern half of SWS*** drop zone (DZ) for contract dredge is:
= (***5***/2) x (***190****43560*0.8 /***45,000****27) = 15 days.
…this is halfway thru the total time expected to fill the site.

Table 2. Values used to estimate Initial Frequency of Site Monitoring (FSM) for 2008.

Disposal Site	Target Mound Height (H,ft)*	Area (A, acres)*	Volume of DM Placed (∀,CY/day)♣ Government		Contractor	FSM** (days)
SWS – East DZ	5	190	35,000	or	40,000	17 or 15
SWS– West DZ	3	100	25,000	or	30,000	7 or 6
SWS DZ	4	290	30,000	or	35,000	24 or 21
NJ Site (west ½)	4	50			13,000	10
DWS (MCR DZ)	30	360	30,000		15,000	232

* = Based on present values; changes as a site is filled; may be redefined based on subsequent site surveys. Based on the need to distribute dredged material disposal over multiple sites, the daily rate of placement within the NJS will be 1/3 to ½ of normal rate.
**= time interval between FIRST successive surveys, assuming site in continuously used AND that dredged material is placed evenly throughout available disposal area. Frequency for Site Monitoring
♣= based on recent average production rates – values will be changed if 2008 production rates are higher

As a given disposal site is “used”, the interval between successive surveys will become smaller. Table 3 shows an estimated schedule for surveying MCR disposal sites during 2008 assuming that disposal occurs continuously in the site and that dredged material is placed uniformly within the available area. The values shown in () are the revised FSMs, following the initial value. An example of how to read table 3 is given for the SWS, and assumes that dredged material is continuously and evenly placed from day one using a contract hopper dredge (production of 35,000 cy/day):

1) 21 days after commencement of the disposal operation, the site would be surveyed and remaining capacity assessed.
2) After 10 additional days, the site would be re-surveyed and re-assessed. The total time for disposal would be 31 days.

3) After 5 additional days, the site would be re-surveyed and re-assessed. The total time for disposal would be 36 days.
4) After 2 additional days, the site would be filled. The total time for disposal would be 38 days.

Table 3. Estimated successive frequency of site monitoring, based on contract (C) dredge and government (G) dredge production rates.

Disposal Site	Initial FSM	2nd FSM	3rd FSM	4th FSM	5th FSM
	days, starting from when site is first used in 2007 (days from previous FSM)				
SWS (C)	21	31 (10)	36 (5)	38 (2)	80% Filled -1.8 MCY
NJ Site (C)	10	15 (5)	17 (2)		80% Filled - 190 KCY
DWS (G)	>120	Survey DWS at Beginning and End of Dredging Season**			

Values indicate cumulative time for which site has been used during 2008.
Values in () indicate successive FSM; or the time that the site can be used been used between successive surveys. When the FSM becomes less than 3 days, use of the site may be temporarily halted while site capacity is evaluated (see figures 2-3).
** Post-Survey of DWS occurs only if the site has been used in 2008.

9. Utilization of Active Disposal Sites during Monitoring and Contingencies

Under certain conditions, active disposal sites may be left alone and others will be used. This means that when the SWS is being surveyed to assess remaining site capacity, the government or contract dredge may use another disposal site until the SWS remaining capacity has been assessed. This will typically take 1-2 days. This may happen towards the end of the dredging season when the SWS is nearing its site capacity. During each site assessment period, the dredges may use the NJ site (if available) or the DWS. See figures 2 and 3a-b.

During periods of rough bar conditions, the SWS or the NJ Site may not be available for use; in which case the DWS may be used. At times during the 2008 dredging season, both contract and government dredges may relocate to other work areas.

10. Optimization of Site Capacity

During 1997-2007, SWS has been the principal disposal site for MCR project maintenance dredged material; 63% of all MCR dredged material (sand) was placed in the SWS. Approximately 93% of the material placed within the SWS drop zone during 1997-2007 has been dispersed by waves and currents, in a north-northwesterly direction onto Peacock Spit (Table B2). It is believed that less than 10% of the dredged material placed at the SWS has been transported southward into the MCR navigation channel. Continued use of SWS as a primary disposal site is of strategic importance to the MCR federal project and environment [USACE 2003]. The western half of the SWS drop zone has been slowly accumulating dredged material, since its initial use in 1997; approximately 1.4 MCY (see figure 18). Management of the SWS has taken this into account by preferentially using the highly dispersive eastern half of the site, and minimizing the additional accumulation within the western half of the site. The net result is to achieve uniform accumulation throughout the site with respect to the baseline condition (1997) without exceeding the site's target height of accumulation; by placing dredged material accordingly to match the site's dispersive and depositional nature. Refer to figure 17 for utilization plans implemented for the SWS during 2008.

The level to which the SWS can be used for dredged material disposal is related to the capacity available within the site and the efficiency to which the site's capacity is used. Regardless of the capacity available within the site, full utilization of SWS capacity can be achieved by promoting even deposition of dredged material throughout the site's drop zone, with respect the baseline condition. This means that the dredged material would be placed though out the entire site, both in space and time, using a regimented procedure to produce a uniform continuous layer on the seabed, avoiding the formation of any localized mounding.

<u>SWS and NJ Site</u>. To promote even and controlled deposition of dredged material within SWS and NJ Site the sites were partitioned into a system of cells (83 cells @ 500 x 500 ft for the SWS and 40 cells @ 250 x 500 ft for the NJ Site) as shown in figure 1a. Initial dump assignments are made for each cell within a given site based on the target mound heights (elevations) for dredged material accumulation. The cell assignments (dumps per cell) are periodically refined as a given site is "filled". As areas of a site become filled; the filled cells are either minimally used or are restricted from use. To facilitate coordination of site assessment, the same placement grid will be used by the contractor and government dredges. Figures 5 and 6 show initial cell assignments for the SWS and NJ Site and constitute the initial (provisional) disposal plan for each site for 2008. It is noted here and elsewhere in this AUP that these disposal plans may be updated using survey data obtained immediately before commencement of the dredging-disposal season.

During 2008, placement of dredged material within either SWS or the NJ Site will be conducted according to the following specification. The SWS and NJ Site shall be filled uniformly with no more than one load difference between any two cells: All cells must be filled with one load before placing a second load in any cell; all cells designated for two loads must be filled before placing a third load in any cell, etc. When recording the placement location, material shall be credited to the cell in which the disposal operation is started regardless of the number of cells disposed in. Each load shall be distributed across no less than 3 cells. No more than 35% of a hopper dredge load shall be placed within any given grid cell. Additional measures may be exercised to maximize capacity within the eastern half of the SWS. The filling of cells may be preferentially weighted toward the eastern half of the site.

<u>Deep Water Site.</u> Dredged material placement within the active drop zone of the DWS will be conducted in a manner similar to the SWS. Figures 1 and 7(a) show the drop zone that will be used within the DWS during 2008 (first used in 2007 as MCR-07-DWS). At the conclusion of 2006 dredging, dredged material accumulation (on the seabed) within the MCR-06-DWS drop zone was approaching 30 ft, with respect to the

2004 baseline elevation (see figure 7 and the 2007 AUP). Based on this expectation, a new MCR-DWS drop zone was selected for 2007 (MCR-07-DWS) to limit mounding within MCR-06-DWS. This DWS drop zone will be used for MCR dredged material placement within the DWS for the next 6-10 years. The intent is to confine the aerial dispersal of dredged material placed within each “drop zone” of the DWS without promoting excessive vertical accumulation of placed dredged material. The outcome achieves pin-point dumping at the DWS. Appendix A describes how a cell-based assignment can be used for the DWS to effectively achieve a concentrated accumulation on the bottom. Figures 7a show initial cell assignments for the drop zones to be used within the DWS and constitute the initial disposal plan for each site for 2008. Drop zones within the DWS shall be used uniformly with no more than 5 loads difference between any two cells. When recording the placement location within each drop zone, material shall be credited to the cell in which the disposal operation is started regardless of the number of cells transited.

11. Data Reporting Requirements

<u>Field Data to be Provided to NWP</u>: Portland District will conduct an internal briefing every week, during the active MCR dredging-disposal season. The Portland Resident Office (EC-R) and Waterways Contracts (OP-NWC) will retrieve digital information describing the contract and government hopper dredge disposal operation (tracklines and beginning-ending dump coordinates). EC-R will verify the integrity of the disposal data. The previous day’s verified disposal data will be provided to EC-HY/HR digitally every day while the dredges are working at MCR. Weekly compilation of disposal tracklines (in digital form) will be provided to EC-HY/HR and EPA-Region 10 weekly. Other data may be transferred to OP-NW and EC-HY/HR, as adaptive site management requirements dictate. EC-HY will review disposal data to verify that the active disposal sites are being used as intended and compare to hydrographic survey results. OP-NWH should provide hydrographic survey information (MCR channel and all MCR disposal sites) to EC-HY in a timely format.

EC-HY will compile survey information, update disposal plans when needed, and disseminate value-added products according to the flow diagram in figure 2. These data will be coordinated with EPA.

<u>Updates from NWP to Public</u>: The Portland District (MCR project manager) will provide updates to collaborating agencies and interested stakeholders periodically – normally every week. Other data may be sent, as adaptive site management requirements dictate.

12. Coordination of Dredging Activities during the Dredging Season

Steps that are taken to increase awareness of dredge locations and disposal management throughout the dredging season include:

1. Public Coordination: The EPA- Region 10 approved Annual Use Plan is coordinated with State Agencies and the public via email and an informational meeting conducted in the local area (Ilwaco/Astoria) prior to start of dredging. The approved Annual

Use Plan is also posted on the Corps' website. A press release is issued to newspapers and radio stations in the local area prior to start of dredging and disposal activities. Key crab fisherman who fish in the area of the Shallow Water Site and the North Jetty Site are notified via telephone two weeks in advance of the dredge starting work in these sites.

2. The Coast Guard is informed of when the work will start and they include this information in their Notice to Mariners. As Dredge Orders are prepared for the Federal dredges, a copy is furnished to the Coast Guard via email for posting in the Notice to Mariners.
3. If two dredges are scheduled to concurrently work the MCR project, a meeting is held (at the beginning of the dredging season) between the Captains of each vessel to discuss communication and coordination. If a contract dredge is assigned to use the SWS or NJS for dredged material disposal, an extensive briefing and tutorial is given to the bridge crew of the contract dredge by NWP to ensure that the contract dredge performs dredging and dredged material disposal according to the requirements set forth in the dredging contract plans and specifications. The plans and specifications for the dredging contract dealing with dredged material disposal at MCR, are based on AUP requirements.
4. Hopper dredges are required by the Coast Guard to employ an intermittent blast from the ship's horn during foggy and low visibility conditions. Hopper dredges are also required by the Coast Guard to display the "ball-diamond-ball" pattern atop her bridge to symbolize her limited ability to maneuver within a navigation channel.
5. Hopper dredges are required by the Coast Guard to display of automated identification systems (AIS) information, which indicates the position, heading, speed, ship length, beam, and type.
6. Nighttime dredging operations require Coast Guard navigation lights mounted at each cardinal location of a dredge.
7. Local newspapers, radio, and media propel public awareness of dredging activity within the area.

APPENDIX A

Mouth of the Columbia River Navigation Project

The mouth of the Columbia River (MCR) is the ocean gateway for maritime navigation to/from the Columbia – Snake River navigation system. The U. S. Army Corps of Engineers is responsible for the operation and maintenance (O&M) of the federal deep-draft navigation channel at the Mouth of the Columbia River (MCR). The MCR navigation channel lies between Columbia River Mile (RM) –3 to +3. The federal navigation project at the MCR is authorized by Rivers and Harbors Act of 1884, 1905, 1954, and Public Law 98-63. The authorized project provides for a 2640-ft wide deep-draft navigation channel across the Columbia River bar. The northerly 2,000 ft of the channel is maintained at –55 ft MLLW (plus 5 ft for over dredging), and the southerly 640 ft of the channel is maintained at –48 ft MLLW (plus 5 ft for over dredging). To achieve the 5 foot of advanced maintenance, in some locations 1-2 feet of material may be disturbed or removed during the dredging process.

The Corps of Engineers-Portland District annually dredges about 4 million cubic yards (MCY) of sand at MCR to maintain the 6-mile long deep draft navigation channel (Table B1). Most of the dredging occurs between RM –2 and +2 and is executed during the summer season. The dredged material is fine-medium sand (0.19-0.25 mm) and fine-grained material content is less than 3%. Due to the exposed ocean conditions at MCR, only ocean-going hopper dredges can perform dredging and disposal at MCR; dredging is limited to summer when wave conditions are favorable for working on the bar. Two hopper dredges are normally used to perform maintenance dredging at MCR: A government operated dredge and a contractor operated dredge, each with different capacities and operating characteristics.

Columbia River and Lower Willamette River Navigation Project

Since 1962, the C&LW federal navigation channel has been maintained at a depth of 40 feet and width of 600 feet, from RM 3.0 to 106.5. This channel configuration was authorized by River and Harbor Act 1962, PL 87-874. Much of the sediment that was dredged from RM 3 to 29 has been placed within estuarine disposal sites. Due to projected capacity limitations of estuarine disposal sites to accept additional dredged material (sand), long-term plans have identified material as far upstream as RM 29.0 as potentially being placed in the ocean, at designated disposal sites [USCE 1998]. Annual maintenance quantities projected to go to designated MCR ocean disposal sites, beginning in 2010-2012, were estimated to average 0.4 MCY per year. Sediment located within the lower Columbia River channel is classified as fine-medium sand (0.20-0.28 mm, with less than 3% silt-clay) and is suitable for placement within the ocean.

In December 1999, Congress authorized the deepening of the C&LW federal navigation channel to 43 feet [Section 101(b)(13) of the Water Resource development Act of 1999]. The existing 600-foot-wide, 40-foot-deep navigation channel is being deepened to -43 feet Columbia River datum (CRD), from RM 3 to RM 106.5. The construction phase of the C&LW channel deepening includes advanced maintenance dredging for over-width and over-depth, in the reaches where this practice is currently performed in the present maintenance program. The C&LW deepening project will be completed in 4-6 phases: The construction (new work) of the 3-ft channel deepening project for the Columbia River is dependent on Federal appropriations. During the construction phase of the 3-foot channel deepening, it was estimated that 6 mcy (4 mcy new work; plus 2 mcy for 40-foot O&M) from RM 3-29 could go to MCR ocean disposal sites [USACE 1999]. Similar to long-term planning conducted for the 40-foot project, future maintenance material from RM 3-29 (associated with the deepened channel @ -43 ft) is expected to go to the ocean, when estuarine disposal sites reach capacity.

In 2005, work (dredging) began to deepen the 600-ft wide navigation channel within the lower Columbia River from -40 ft to a newly authorized depth of -43 ft CRD (-45 ft to -48 ft when considering advanced maintenance). During 2005 (phase I of C&LW channel deepening), approximately 1.3 MCY of the "new work" sediment was dredged from the lower Colombia River channel via hopper dredge, between river mile (RM) 5 and 21, and was placed within the Deepwater Site (DWS). The DWS is located 7 miles offshore the mouth of the Columbia River. In 2006 (phase II), approximately 1.1 MCY of "new work" C&LW material was dredged between RM 21 and 29 and placed within the DWS using a hopper dredge. During 2007 and 2008, there was no Columbia River dredged material placed or expected to be placed within the DWS.

The Hopper Dredge

A hydraulic hopper dredge is a self-propelled seagoing ship with sections of its hull compartmented into one or more holds or "hoppers". It is normally configured with two drag arms, one on each side of the dredge. During dredging, bottom sediment is sucked into the drag arm by hydraulic pumps and deposited into the dredge's hoppers. The dredged material enters the hoppers in slurry form and settles to the bottom as excess water flows over the top of the hoppers. Once the hoppers are full, the drag arms are lifted, and the dredge transits to the disposal area where the dredged material is usually dumped thru doors located on the bottom of the ship (hoppers). In some cases, the hopper dredge can use its pump to discharge the dredged material directly overboard or thru a pipeline to a disposal site not reachable by the hopper dredge (i.e. beach, upland, or nearshore locations). This is often referred to "pump-ashore" dredged material placement. During 2008, approximately 125 KCY will be placed using the "pump-ashore" method in an upland area along the north side of the MCR north jetty. The operating parameters for several dredges that have been used at MCR are shown below.

Table A-1. Operating parameters for hopper dredges commonly used at MCR

DREDGE	OVERALL DIMENSIONS			CAPACITY	VESSEL	TIME TO PLACE	
	length (ft)	beam (ft)	draft(ft) loaded/empty	load-average (cy)	type	open water dump (minutes, per load)	pump-out
Newport*(Cntr)*	300	55	20/10	3,000	split-hull	4 to 8	N/A
Padre Island*(Cntr)*	281	52	19/8	2,700	split-hull	4 to 8	N/A
Essayons*(Gvt)*	350	68	30/15	5,400	bottom doors	6 to 15	120 to 140*****
Terrapin Island*(Cntr)*	340	68	22/10	3,400	split-hull	4 to 8	60 to 120
Stuyvesant*(Cntr)*	372	72	29/17	8,000	bottom doors	6 to 15	130 to 160

*** may have pump-out capability in 2008**

Hopper dredges are used mainly for dredging in wave exposed or high current areas where traffic and operating conditions preclude the use of more stationary dredges and their attendant pipeline or dump scows. Hopper dredges are effective working offshore and in entrances where sea and weather conditions preclude the use of extensive dredge pipe (associated with pipe-line or cutter-head/hydraulic dredges). Most hopper dredges are capable of operating in ocean swell 8-10 ft high which is required for ocean inlet dredging and accessing disposal sites many miles from the dredging location. The government hopper dredge (*Essayons*) utilizes a series of "doors" located on the hull bottom to release each load of dredged material. The bottom doors are sequentially opened during disposal until the entire load of dredged material is released from the vessel resulting in a gradual release of dredged material from the vessel. Contractor hopper dredges typically employ a split-hull design. A split-hull hopper dredge releases its load of dredged material by opening (splitting) the entire hull of the vessel. The split-hull method of disposal is more rapid (time-efficient) than bottom-door hopper dredges. While the use of split-hull hopper dredges reduces the time required for material disposal, split-hull dredges reduce the horizontal dispersal of dumped dredged material on the seabed while increasing the vertical extent of accumulation per dump.

MCR Disposal Site Utilization: Procedures and Governing Constraints

Both the Shallow Water (SWS) and Deep Water Sites (DWS) were configured based on hopper dredge operating characteristics. The Deep Water Site is large enough that barge-disposal of material would not be a problem. At the Shallow Water Site, dredged material placed using a barge/scow would likely not erode and disperse as readily as material placed by a hopper dredge. Due to less control and maneuverings limitations of a barge and tow, placement of material in the SWS by this equipment may not be possible. *Before any non-hopper dredged material may be discharged at the Shallow Water Site, a specific evaluation (potentially including sophisticated modeling) must be completed and submitted for approval by the USEPA* [USACE 2005].

Disposal Site Terminology: The ***Placement Area*** of a disposal site defines the extent of sea bottom that will be occupied by disposed dredged material released at the water surface on an annual use basis, and/or over the anticipated life of the disposal site. A ***drop zone*** is a defined area at the water surface within the placement area and within which dredged material discharge may occur. The drop zone for the SWS and the DWS are shown in figure 1 (dashed black line). The Drop Zone may be further subdivided into "cells" for more specific placement control (i.e. area MCR-07 within the DWS). A ***Buffer*** is that area of the sea bottom between the defined limit of the placement area and the disposal site boundary. Direct disposal into the buffer is prohibited. Consult the SMMP for additional information [USACE/USEPA 2005].

Shallow Water Site (formally ODMDS E): The entire SWS occupies a trapezoidal area of 3,100 to 5,600 ft wide x 11,500 ft long and lies within 2 miles offshore from MCR in a water depth of 45 ft to 75 ft (see figure 1 and 8). The SWS drop zone is 1,054 ft to 3,600 ft wide by 10,000 ft long (and is equivalent to the former Section 103 ODMDS E). The SWS was designated in 2005, under the Section 102 of the MPRSA as described in USEPA [2005]. The SWS is of strategic importance to the region; its continual use has supplemented Peacock Spit with 75 million cy since 1973, maintained the littoral sediment budget north of MCR, protected the north jetty from scour and wave attack, and stabilized the MCR inlet. It is USACE's position that the SWS must be continued to be used to maintain the MCR inlet and supplement the sediment budget north of the MCR (see Appendix B). Prior to 2008, approximately 27 MCY of MCR dredged sand had been placed within the SWS (during 1997-2007). As of 1 April 2008 approximately 2.2 MCY of this material remain within the SWS drop zone, with respect to the site's 1997 baseline condition (figure 9 and 10). Results obtained from extensive analysis of the SWS indicate that the site can accommodate 4-6 MCY of accumulation within the drop zone baseline bathymetry without creating hazardous wave conditions, provided that the dredged material deposition is uniform throughout the drop zone [USACE 2003]. The SWS is configured so that the site is large enough to allow for the temporary storage of placed dredged material as it is naturally dispersed into the littoral zone during the dredging season avoiding the creation of conditions that could interfere with navigation safety.

Figure 11 shows the *target contour elevations* for the SWS: These contours account for a 5-ft accumulation added onto the site's baseline (1997) bathymetry (compare to figure 9). As of 1 April 2008, the SWS present *static* target capacity is 2.2 MCY; this is the static volume that can be realistically placed within the SWS drop zone (figure 12). The static target capacity is what would be achieved if there were no dispersion of placed dredged material during the dredging season. The western half of the site is typically less dispersive than the eastern half of the site. Figure 12 shows the *contour heights* at which dredged material can accumulate within the SWS, without exceeding the site's management target (with respect to May 1997), based on the 1 April 2008 survey. As of 1 April, the average height of accumulation that can be achieved during 2007 without exceeding the target contour elevations for the eastern and western areas of SWS is 5 ft and 3 ft, respectively.

Note that as of 1 April 2008, the *effective* target capacity within the Shallow Water Site (SWS) for the 2007 dredging season was estimated to be 3.0 MCY. The effective target capacity assumes that dredged material accumulates to the present target level within the site's drop zone and accounts for the dredged material side slope and the dispersive potential of the SWS. Between 20-50% of the material placed within the SWS is dispersed out of site's drop zone during the dredging season (June-October), based on site monitoring during 1998-2007 (see Table B-2). Refer to Appendix B for additional information concerning dredged material deposition within the SWS. The effective target capacity within the SWS drop zone can increase or decrease, depending upon prevailing wave-current conditions. Active monitoring of the SWS bathymetry during the dredging season is conducted to evaluate the current capacity of the SWS. During 2007, full utilization of the SWS began in mid July, approximately 1 month later than normal. Approximately 30% of the placed dredged material was dispersed out to the SWS during the 2007 dredging season. The same timing in SWS use is expected in 2008. Deferred use of the SWS may reduce the capacity of the site to disperse placed dredged during the dredging season. Active monitoring of the SWS during 2008 will be used to assess the effective target capacity of the site.

To avoid exceeding the management target for dredged material accumulation within the SWS (with respect to the baseline condition- May 1997), dredged material will be placed such that it accumulates uniformly throughout the site, both in space and time. This means that the entire site will be utilized, to the maximum extent practicable.

<u>North Jetty Site (NJS)</u>: The NJS is located approximately 200 ft south of the MCR north jetty and occupies an area of 1,000 ft x 5,000 ft (figures 1 and 13). The average water depth within the NJ Site is 35 ft to 55 ft, below MLLW. The NJS overall site boundaries are coincident with the site's drop zone boundary and placement area boundary. The NJS was selected in 1999, under Section 404 of CWA, for the purpose of allowing the placement of MCR dredged material along the toe of the north jetty. Placing dredged material along the north jetty toe is needed to reduce severe undermining of the jetty by wave and current scour. Approximately 4.2 MCY were placed within the NJS during 1999-2007. As of 1 April 2008, 1.0 MCY remained within the NJS. It is acknowledged that some of the dredged material placed at the NJS is transported toward the navigation channel. So long as the amount transported from the NJS to the channel per year is small (less than 30% of the amount placed), the value of reducing scour along the north jetty outweighs the cost of re-handling the dredged material placed at the NJS. In consideration of the above, use of the NJS is curtailed from previous levels (0.5 MCY/yr).

As of 1 April 2008, the *effective* target capacity of the NJS was estimated to be 0.2 MCY, assuming that 70% of the NJS is permitted to accumulate dredged material to a height of 8 ft (with respect to the site's baseline 1999 condition). Refer to figure 14. The present target capacity for the NJS does not account for any dispersion of dredged material placed within the site. Due to the relatively shallow water depths thru the NJS, care will be taken to place dredged material such that it accumulates evenly within the site and the entire site should be utilized, to the maximum extent practicable. Placement of dredged material within the eastern half of the site is restricted during 2008 to prevent additional accumulation within that part of the site.

Deep Water Site: The entire DWS occupies an area of 17,000 x 23,000 ft and lies 6 miles offshore from MCR in a water depth of 190 ft to 300 ft (see figure 1). The DWS has a defined placement area, which is inscribed within the overall site boundary by a 3,000 ft buffer zone, separating the DWS boundary from the DWS placement area (see figure 7). The DWS placement area is 11,000 ft x 17,000 ft. The DWS was designated in 2005, under the Section 102 of the MPRSA as described in USEPA [2005], to provide sufficient capacity for the disposal of dredged materials to meet current and anticipated future ocean disposal needs at the MCR. Placement of dredged material within the DWS is limited to specific “drop zones”, which are inscribed within the DWS placement zone. The intent is to confine the aerial dispersal of dredged material placed within the “drop zone” of the DWS without promoting excessive vertical accumulation of placed dredged material, while reducing the areal extent of dredged material deposition. Use of the DWS occurs ONLY when the nearshore disposal sites have been used to the maximum extent practicable or when inclement weather conditions or operational constraints temporarily preclude the safe use of the other disposal sites.

In 2003, part of the DWS became available for use for the first time (as a Section 103 site). It was not used that year as it was a below average shoaling year and there was adequate capacity in the SWS and NJS. In 2004, part of the DWS was used for the first time (as a Section 103 site) for the disposal of 1.7 MCY of sand dredged from the MCR channel. The DWS area used in 2005-2006 was the same as the drop zone used in 2004 (MCR-06-DWS, figure 31). A total of 4.15 MCY was placed within MCR-06-DWS drop zone during 2004-2006. In 2007, a new drop zone was selected for MCR dredged material placement within the DWS (MCR-07-DWS, figure 7), as dredged material deposition within MCR-06-DWS had approached the target level of 30 ft (figure 31). Refer to Appendix B for additional information concerning dredged material deposition within the DWS.

One (1) DWS drop zone is available for use during 2008, for the placement of MCR dredged material: The MCR-07-DWS drop zone is 4,000 X 4,000 foot (367 acres) and resides in a water depth of 220-235 ft. The MCR-07-DWS drop zone can accommodate approximately 12 MCY total deposition with an overall target mound height of 20-30 ft. During 2008, only sediment dredged from the MCR will be placed within the MCR-07-DWS. Figure 7a shows the initial 2008 placement plan for the MCR-07-DWS.

NJ Berm Site: Approximately 125 KCY of MCR sand is expected to be placed adjacent to the north jetty (figure 1 and 1a) during a 3 week period within the timeframe of 15 July - 15 September 2008. The dredged sand will be pumped to shore from the contract hopper dredge *Terrapin Island* through a 16- to 30-inch pipe passing over the top of the North Jetty onto Benson Beach. The placement area is an upland zone extending 500-1,000 ft along the north jetty; between elevations of +7 and +20 MLLW, and extends northward away from the jetty for a distance of 900 ft. Placement of sand along the north jetty is required to re-establish the primary dune adjacent to the north jetty, thereby protecting the root of the jetty from breaching. The present situation was motivated by the primary dune along the North Jetty being washed out during winter storms of 2006-2007, making the pre-existing scoured area along the north side of the North Jetty susceptible to connection with the ocean during lower intensity storms. The prospect of future connections between the ocean and the scoured area is of concern because of the potential for weakening and breaching of the jetty with future storms. Use of the NJ Site may be restricted during the 3-week period when dredged material is to be placed at the NJ Berm project area.

Previously Used Disposal Sites: The de-designation of ODMDSs previously used at MCR is described in USEPA [2005]. The MPRSA Section 103 part of ODMDSs A, B, and F (as expanded in 1993) expired in Fall 2002, leaving the original 1986 EPA-designated areas (Section 102) of ODMDSs A, B, E and F. In April 2005, EPA de-designated the original ODMDSs A, B, F and modified ODMDS E. The modified ODMDS E was renamed the SWS. USEPA (Region 10) designation also voided the Corps' selected Section 103 ODMDS E. Refer to Table B-1 for a summary of MCR open water disposal site use during 1956-2007.

Wave Model Application for Assessing Dredged Material Mounding at MCR

Numerical models (solved by computer) can be used to simulate the behavior of waves (wind, waves, and swell) as the waves approach the shore and become modified by limiting water depth, wind, and currents. In this capacity, numerical wave models can be used to evaluate the effects of waves interacting with dredged material mounding. Utilization of the SWS is predicated upon limiting dredged material accumulation within the site so as to avoid negatively affecting waves passing through the site. Numerical wave modeling has been used to ensure that SWS utilization complies this wave-related operational requirement.

RCPWAVE is a monochromatic wave model used to simulate modification of nearshore waves associated with shoaling (wave height change due to water depth change) and refraction (wave height and direction change due to spatial variation in water depth change). Because RCPWAVE is a monochromatic wave model (all waves are assumed to be identical in period, height, and direction), it can overestimate nearshore wave evolution by as much as 50%. Since RCPWAVE tends to over estimate nearshore wave height, it was used to establish a conservative target level for dredged material mounding (described in Section 4 of the AUP). Due to the inherent nature of RCPWAVE to over predict nearshore weave height, it is no longer used by USACE to quantify nearshore wave evolution where engineering applications require accurate determination of wave parameters needed to achieve optimized (least cost) coastal design.

STWAVE is a steady-state spectral wave model developed for simulating nearshore wave transformation and is presently the standard USACE wave model for estimating wave refraction and shoaling. STWAVE uses the wave action conservation equation, solved in the frequency domain using phase averaging to simulate wave propagation and estimate wave height, period, and direction at a given location (x,y). Time-varying information describing the changes in wave phase and superposition of waves having different phases is not presented. Phase-averaging limits this model from directly solving for wave diffraction and reflection caused by very steeply-sloped bathymetric features and surface piercing structures. However, approximation methods have been incorporated into STWAVE to indirectly account for wave diffraction and reflection [Smith 2003]. STWAVE has been extensively applied, calibrated, and verified throughout the US and the world. Refer to Moritz et al (2006) for a discussion of STWAVE application at MCR. The physics affecting waves in the nearshore area of Peacock Spit, including the SWS, are limited to shoaling and refraction; processes for which the STWAVE model was developed to simulate [USACE-USEPA 2003]. There are essentially no diffraction or reflection effects occurring within the SWS or nearshore areas of Peacock Spit, west of the offshore of the MCR jetties. In this regard, the STWAVE model is appropriate for assessing wave modification on Peacock Spit and within the SWS due to mounding of placed dredged material. The gradual varying bottom gradient (slope) of the bathymetry and mounding within SWS is consistent with the formulation of STWAVE; i.e. the bottom gradient with the SWS is not so rapidly changing as to be invalid for STWAVE application.

Should mounding within the SWS exceed specified management thresholds, as described in Section 5 of this AUP, the STWAVE model will be used to evaluate the effects of dredged material (mounding) upon the wave environment of Peacock Spit. Refer to Section 7 of the AUP for a discussion of post-disposal wave modeling for MCR. STWAVE results for the post-2007 disposal assessment are summarized in Appendix B.

APPENDIX B

Utilization of MCR Disposal Sites During 2007

During 2007, approximately 4.2 million cy of sand was dredged from 6-mile long MCR deep draft navigation channel. Approximately 2.3 million cy was placed within the SWS, 0.2 million cy was placed within the NJ Site, and 1.7 million cy was placed within the MCR-06-DWS. No CRCIP "new work" or C&LW dredged material was placed within MCR disposal sites during 2007.

Figure 15 highlights the distribution of dredged material placed at MCR during 1956-2007, in terms of nearshore (north and south of the entrance) and deepwater (greater than 55 ft depth) locations. Note that during 1956-1996, most of the material dredged at MCR was placed in the nearshore, with equal distribution to the north and south of MCR. During 1997-2006, 71 % of the sediment dredged at MCR was placed within the nearshore area north of the entrance. The three right-hand graphs in Figure 15 show that the relative amount of dredged material placed within the nearshore (littoral) area of MCR is decreasing with time. The percentage of dredged material placed in the nearshore for 2007 was 46% of the total dredged; the percentage placed nearshore in 2006 was 60%, and the averaged percent placed nearshore for 1997-2006 was 71%. In an effort to re-initiate the balance in nearshore placement at MCR (north and south distribution), 34,000 cy was placed within the South Jetty Research Site in 2005. This was a first step in a multiphase effort to evaluate the feasibility (operational and environmental) of programmatically placing MCR dredged material within the nearshore area south of MCR. The purpose/objective of a South Jetty nearshore disposal site would be to augment the littoral sediment budget south of the MCR and protect MCR south jetty from evolving scour and increasing wave action associated with the present sediment deficit.

Figure 16 shows the distribution and timing of MCR disposal site use during 2007. Note the times when the SWS was used (and not used). The government dredge *Essayons* used the SWS for a 2 week period beginning on 13 July; after which time the government dredge used only the DWS for MCR dredged material placement. This was done to: A) Prevent overloading of the SWS at the beginning of the 2007 dredging season, and B) Allow the contract dredge to have the maximum capacity available for the NJS and SWS. Non-use of the SWS during a 30-day period (end of July to end of August) allowed time for the material placed within the site during 13-28 July to be dispersed out of the site (renewing site capacity), before the site was again used in late August . The SWS was used most heavily during mid-October, when the contract hopper dredge *Terrapin Island* placed 0.25 MCY within the SWS during a 5-day period. Approximately 30% of the material placed within the SWS during 2007 was dispersed out of the site's drop zone during the 2007 dredging season. To reduce the rate of material placed within the SWS and NJS (and increase dispersion of placed material), dredged material disposal was distributed between the SWS and the NJS (or DWS) based on a daily 70%-30% split.

SWS: The utilization of the SWS during 2007 is illustrated in figures 17-25, and is expressed in terms of material placed and deposition realized. Figure 18 shows the level of sediment accumulation within the SWS at the beginning of the 2007 dredging season (June 2007) with respect to 1997; maximum accumulation was 5 ft. Figure 17 shows the 7 dump-plans that were used to manage dredged material placement within the SWS during 2007. Note the instances (in plans 1, 3, and 4) when dredged material placement was restricted through much of the site's western half to ensure that the height of deposition did not exceed management threshold (Section 5 of the AUP). Figure 18 illustrates the degree of deposition within the SWS at the beginning of the 2007 dredging season, with respect to the site's baseline condition (1997). Dump plans 1-7 (figure 17) were used to limit the vertical level of deposition within the SWS to 5-6 ft with respect to the 1997 baseline condition. Figures 19-24 show how dredged material accumulated within the SWS during 2007, in response to the contract dredge and government dredge using the site. Figure 19 shows the total accumulation of dredged material placed within the SWS during 2007 season (June-November), with respect to June 2007. Figure 19 demonstrates the overall attempt to utilize available capacity within the SWS during 2007, expressed in terms of realized dredged material deposition on the seabed. The eastern 1/3 of the SWS was used more intensively compared to other areas within the site, to take advantage of the higher dynamic capacity (dispersion + static capacity) at this location. Dredged material placement was managed around areas of prior accumulation so that total accumulation at the end of 2007 would not exceed 5 ft with respect to the 1997 baseline condition (compare to figures 18 and 19).

Figures 20-21 illustrate effectiveness of the government hopper dredge (*Essayons*) at distributing 0.42 MCY of dredged material within available areas of the SWS during 13-28 July 2007. Compare figure 20 to figure dump plan #1 in figure 17. Localized deposition of dredged material placed within the SWS (by the *Essayons*) was 1-3 ft high, with most of the material placed and depositing within the eastern ½ of the site. The areas of prominent deposition generally correspond with the areas of dredged material placement. Note how the western half of the SWS was not used; with some erosion of the seabed occurring during June- July 2007. The overall trend of bathymetry change within the SWS during June – July 2007 was that deposition of sediment within the site was greater than the volume of dredged material placed within the site. Approximately 73% MORE material deposited on the seabed within the SWS than what was placed during June – July 2007. This trend is unusual for the SWS. Normally, 30 % - 40% of the material placed within the SWS is dispersed out of the site during the dredging season. A possible cause for the higher than normal ambient deposition within SWS, was that finer materials were depositing within the nearshore of MCR during the summer calm of July.

The contract hopper dredge (*Terrapin Island*) placed 1.3 MCY within the SWS during 30 August to 28 October 2007. Figures 22-23 show how the material was dispersed throughout available areas of the site and the resulting deposition. Localized deposition of dredged material placed within the SWS by the *Terrapin Island* was 2-5 ft high within the eastern half of the site and 1-2 ft in the western half of the site. Dredged material was distributed evenly between the west and east half of the SWS, on a volume basis. The areas of prominent deposition generally correspond with the areas of more focused dredged material placement. Note the focused area of deposition within the eastern 1/3 of the SWS. Measures were taken to place more material within this area (in accordance with a higher a site capacity) while disturbing the material to avoid locally excessive mounding. Although the placed dredged material did mound in this area, the mounding was not excessive (generally less than 5 ft). The net deposition within the SWS during Aug – Nov 2007 was approximately 700 KCY, which was 600 KCY (45%) LESS than what was placed during the same time period (1.3 Mcy).

Refer to figure 19, for an illustration of SWS bathymetry change during June-November 2007. The total net deposition within the SWS for the entire 2007 dredging season (June – November 2007) was 1.21 MCY, which was 540 KCY (31%) LESS than what was placed. In other words, 31% of the material placed within the SWS during 2007 was dispersed out of the site during the dredging/disposal season. This value was 5-10% less than the annual average for 1997-2006.

The SWS was utilized fairly late into the 2007 dredging season (last day used was on 28 October). At that point in time, regional wave conditions had deteriorated such that the SWS could no longer be safely accessed by the hopper dredge. When the SWS and NJS were no long accessible, the DWS was used exclusively for the remainder of 2007 dredging (through 2 November). Figure 24 shows that as of 6 November (9 days after completion of SWS utilization for 2007), the maximum accumulation of sediment within the SWS had reached 6 ft with respect to 1997 (covering an area of 500 ft x 800 ft). At end of the 2007 dredging season, the SWS was at a “level 4” status (acceptable) in terms of the site’s Decision Framework for Site Management (see Section 5 of the AUP).

Figure 25 illustrates the degree of erosion which occurred within the SWS during winter 2007 (November 2007 – April 2008). The seabed within the SWS was lowered by 1 to 4 ft during winter 2007, resulting in a net loss of 1.53 MCY of sediment (dredged material previously placed within the site). Note that the most aggressive erosion trend during winter 2007 was associated with the most prominent area of deposition occurring during the 2007 dredging season (compare to figure 23). Figure 26 shows the SWS bathymetry difference between spring 2008 and spring 2007. The eastern 1/3 of the SWS is approximately 1 ft higher now (April 2008) that it was 1 year ago, whereas the western half of the SWS is 1-2 ft lower. Note the area of deposition within the MCR federal navigation channel south of the SWS. This deposition is believed to originate from sources south of the MCR channel (sediment eroded from Clatsop Spit and areas southwest of the south jetty during the severe storms of winter 2007).

Figure 27 shows the degree of bathymetry change that has occurred on Peacock Spit and adjacent areas during 1958 to 2007. Had 75 MCY of dredged material not been placed at the SWS during 1973-2007 (25 MCY since 1997), Peacock Spit would presently be much smaller and deeper than the present condition. The consequences of this scenario would be grave for the stability of the MCR north jetty, the inlet, and the shoreland north of MCR. The arrows on figure 27 portray the inferred sediment transport pathways from the SWS. Based on the information portrayed in figure 27, use of the SWS is significantly augmenting the stability of Peacock Spit, the inlet, and the north jetty.

DWS: During 2007, the government hopper dredge *Essayons* and the contract hopper dredge *Terrapin Island* collectively placed 1.8 MCY of MCR dredged sand within the MCR-07-DWS drop zone, using a cell-based plan very similar to what was previously used for the MCR-06 DWS area (USACE 2006). The resultant distribution of dumps throughout the MCR-07-DWS was almost uniform (figure 28). Figure 29 shows that the deposition on the seabed associated with 2007 disposal activities was overshadowed by previous dredged material disposal at the MCR-06-DWS drop zone (site no longer used after 2006). Based on the overall deposition pattern shown in figure 29, it is estimated that the height of deposition within MCR-07-DWS associated with 2007 activities is 2-6 ft (with respect to the baseline condition of 2000).

NJ Site: Utilization of the NJ Site during 2007 is summarized in figure 30. The contract dredge *Terrapin Island* used the NJ Site during 2007 for a limited volume of dredged material placement (211,000 cy). Some accumulation of sediment was observed to have occurred within the center of the NJ Site during 2007 (see figures 13-14). This localized accumulation is assumed to be dredged material that was placed within the NJS during 2007. Use of the NJ site during 2007 will be limited to 200,000 cy due to the persistent accumulation within the site. Some of this material is believed to have originated from sand that had been transported through the north jetty (from Benson Beach) during intense winter storm activity (refer to the next section for details). As of 1 April 2007, the degree of cumulative deposition within the NJS was less than that observed in the 4 previous years (spring season).

Special Studies Conducted During 2007

Several studies were conducted during 2007 to assess the potential effects of dredged material placement within MCR disposal sites, as required by the SMMP and other regulatory frameworks. In summary, these activities included continued development of the ARGUS beach monitoring system (ABMS) at North Head, Modeling of Wave Action within the Shallow Water Site -1997 vs. 2007 Bathymetry Condition at MCR, and Conclusion of the SWS Sediment Tracer Study. Results obtained from the 2007 special studies are summarized in figures 33-46.

ABMS at North Head: The ARGUS beach monitoring system (ABMS) at North Head has been operational since 2004 and is used to verify that wave action on Peacock Spit is not negatively affected by the SWS (http://www.planetargus.com/north_head). Figure 31 highlights the utility of the ABMS to monitor wave action along the southern extent of Peacock Spit (including the SWS). The bottom panel of figure 31 shows merged images from the 8 ABMS video cameras installed within the North Head lighthouse, view is to the south (7 Feb 2005). The SWS boundary is shown as a yellow line element in each image (bottom panel). Note the breaking waves that appear to boarder the northern boundary of the SWS. The top panel of figure 35 shows the rectified imagery (planemetrically correct) obtained from the bottom panel. The blue line shown within the top panel is the SWS drop zone, view is to the east. Note the location of wave breaking shown in the top panel; the waves are breaking 1 km north of the SWS. The North Head ABMS system continually updates the video imagery of Benson Beach and Peacock Spit every hour; the imagery is available to the public and can be accessed at the above website. Improved functionality has recently been added to the ABMS to monitor and convey real time wave action within the SWS using an hourly-updated "map". If wave breaking is observed within the SWS, the Portland District will assess the severity of the situation, potential causes, and inform EPA and stakeholders of the situation. The North Head ABMS is also used to assess the stability of Peacock Spit and Benson Beach, in context to littoral sediment transport, SWS use, and morphology change (figure 32).

The ABMS system has also been used to investigate the nearshore dynamics of Peacock Spit; which includes the potential pathway for littoral sediment exchange between Benson Beach, Peacock Spit, and the SWS. The behavior of the south portion of the offshore sand bar along Benson Beach system suggests that it has not been in a "Seasonal Dynamic Equilibrium" during the 4 years of ABMS observation. There is only a two-bar system suggesting that there is not enough sediment to sustain the three bar system observed to the north. The outer and middle bars merge during winter months, suggesting again, there is not enough sediment at times to sustain the two-bar system. A sediment starved bar system must acquire sediment from other sources outside of the nearshore littoral system to rebuild the two-bar system or to detach the bar from the shoreface. Possible sources are from dredge material placed at the SWS and/or erosion of the beach above MHHW. SWS sediment may feed offshore sand bars that in turn migrate shoreward during summer months, feeding the intertidal zone of Benson Beach. The summer time disposal of dredge material on the SWS is not only optimal for safety but may also be optimal for sediment transport away from the MCR and onto Benson Beach. Further study is ongoing to substantiate this. For details refer to:
http://www.planetargus.com/north_head/news/

Wave Modeling: Estimates of wind-wave and swell behavior associated with the present nearshore bathymetry condition at the Mouth of the Columbia River (MCR) were derived using a numerical wave model (STWAVE, computer simulation). These results were compared to those for 1997, to assess the potential changes in the wave environment due to bathymetry change. A similar analysis was conducted in 2003 to compare bathymetry and waves conditions in 2002 to 1997 (USACE 2003). This report applies the same rationale and offshore wave environment as used in USACE 2003 to compare the bathymetry and wave conditions for 2007 to those of 1997. Eleven (11) distinct offshore wave (boundary) conditions were used in this analysis, representing approximately 82% of the annual PAC NW wave environment. Table B-1a summarizes STWAVE results for all 11 wave scenarios, in terms of the simulated change in wave conditions occurring within the SWS during 1997 and 2007.

The nearshore bathymetry at MCR is in a continual state of flux, due to the high energy of waves and currents at the inlet. Construction of jetties (1885-1917) at the inlet has added to the dynamic of morphology change. The nearshore bathymetry of MCR is continuing to evolve. One manifestation of this nearshore evolution is that ephemeral features like Peacock Spit and Clatsop Spit are being eroded by the natural forces of waves and currents. As the bathymetry across Peacock Spit and Clatsop Spit progressively changes, the nearshore wave environment will change accordingly. During 1997 to 2007, these "natural" bathymetry changes have been equivalent to the changes that have occurred at the SWS due to dredged material disposal (figures 33-34).

The STWAVE model [Smith et al 2001] was run for two bathymetry conditions (years): 1997 and 2007. A total of 44 model runs were conducted for this investigation. Each bathymetry condition (1997 and 2007) was represented by two STWAVE grids. A "southwestern grid" used to simulate the waves approaching MCR from the W-SW, and a "western grid" used to simulate the wave approaching MCR from the W-NW. Five to six different offshore wave (boundary) conditions were applied on each grid. Each STWAVE grid covered a region of approximately 18 km (offshore) x 60 km (alongshore), descretized using cells 61 m x 61 m. The vertical datum (seabed elevation) was referenced as MLLW. Actual offshore wave data (directional spectra) were used as boundary conditions to "drive" the STWAVE model. The offshore wave data were observed at NDBC buoy 46029, located 25 km offshore MCR.

Four (4) different types of STWAVE output are highlighted here to illustrate how each wave cases summarized in Table B-1a was evaluated. Figure 35 shows the observed wave condition used to drive "Case #8" wave scenario. Figure 36 shows the comparison of wave height for the 1997 and 2007 bathymetry conditions. Figure 37 shows the relative change in wave height that occurred between 1997 and 2007 within the region of interest for Wave Case #8. Figure 39 shows the degree of wave height amplification that occurred between 1997 and 2007 within the region of interest for Wave Case #8 . Table 1 summarizes STWAVE results for all 11 wave scenarios, in terms of the simulated change in wave conditions occurring within the SWS during 1997 and 2007.

STWAVE results indicate that the wave-related effects of "natural" bathymetry change at MCR during 1997-2007 are similar to the wave-related effects of using the SWS for dredged material disposal. During 1997 to 2007, the "natural" processes of erosion and deposition at MCR have potentially modified wave height on Peacock Spit and Clatsop Spit by 10-20%. In many cases, wave height changes associated with erosion of Peacock Spit and Clatsop Spit confound the change in wave conditions at the SWS. Care must be taken not to ascribe a bathymetry-related wave impact to the SWS, when the effect is in fact due to evolution of Peacock Spit.

When waves approach the MCR from the South-Southwest (S-SW), waves first encounter the bathymetry along the southern side of Peacock Spit (including the SWS) before sweeping northward and eastward across the highest areas of the spit. This means that for southerly waves, bathymetry change within the SWS will have more potential to effect the local wave environment within the SWS and northward on Peacock Spit, than areas south of the SWS. Comparing conditions in 1997 to 2007, deposition of dredged material within the SWS had potentially increased nearshore wave height (within the site or at nearby locations) by 2-5%, for S-SW waves (cases #1-#5). Results are summarized in table 1.

When waves approach the MCR from the West-Northwest (W-NW), waves first encounter the shallow bathymetry along the western or northern side of Peacock Spit then sweep southward and eastward across the highest areas of the spit, before the waves encounter the SWS. This means that for W-NW waves, there is complex interaction of waves with Peacock Spit first and then the SWS. Bathymetry change within the SWS will have more potential to effect the local wave environment within the SWS and areas southward, than for areas north of the SWS. Comparing conditions in 1997 to 2007, deposition of dredged material within the SWS had potentially increased nearshore wave height (within the site or at nearby locations) by 5-11%, for W-NW waves (cases #6-#11). Results are summarized in table B-1a.

Based on the results described above, offshore waves approaching MCR from the W-NW are affected to a greater extent than offshore waves approaching from the S-SW because of the complex shoaling/refraction of waves when they pass over Peacock Spit before they reach the SWS. The STWAVE results presented herein indicate that the MCR wave environment (during 1997-2007) is affected more by the evolving nature of the inlet's large-scale morphology than by deposition of dredged material within the SWS. As of November 2007, the level of dredged material mounding within the SWS and associated wave interaction is within the target management level as described in the SWS Annual Use Plan (USACE 2007) and Site Management and Monitoring Plan (USACE 2005).

Wave Case		Offshore Wave Height (m)	Offshore Wave Period (sec)	Offshore Wave Direction (deg)	Annual Occurrence %	Wave Height in SWS 1997 (m)	Wave Height in SWS 2007 (m)	*1997 vs. 2007 Wave Amplification at SWS*
1 S-W	Winter Storm	6.48	12.5	225	1.48%	6.4	6.7	5%
2 S-W	Winter Storm	8.34	16.7	260	0.37%	8.1	8.3	2%
3 S-W	Winter Storm	6.78	10.5	210	1.55%	5.2	5.3	2%
4 S-W	Summer Storm	3.56	7.7	200	3.18%	2.8	2.9	3%
5 S-W	Summer Storm	3.51	10.5	175	1.05%	2.8	2.9	4%
6 NW-SW	Summer Swell	1.79	11	275	24.05%	2.0	2.1	7%
7 NW-SW	Winter Swell	2.85	16.7	280	12.73%	2.9	3.2	11%
8 NW-SW	Summer Swell	1.29	16.7	225	2.66%	1.4	1.5	5%
9 NW-SW	Winter Swell	1.77	8.3	305	21.75%	1.9	2.1	10%
10 NW-SW	Winter Swell	3.75	16.7	275	11.78%	3.9	4.3	10%
11 NW-SW	Winter Storm	6.55	14	310	0.94%	6.6	7.1	7%

Table B-1a. Summary of offshore wave conditions used to assess the potential change in nearshore wave conditions at MCR associated with bathymetry change within the SWS ODMDS and other areas at the inlet during 1997 -2007. FAR right column lists the estimated MAX wave amplification factor within the SWS due to bathymetry change during 1997-2007.

Sediment Tracer Study at SWS: In September 2006 Portland District (NWP) initiated a sediment tracer study at the SWS. Moffatt & Nichol Inc was contracted by NWP to perform the study with assistance from Evans-Hamilton, Inc and Environmental Tracing Systems, Ltd. The fieldwork for phase I of the tracer study spanned from September to December 2006 and focused on the SWS with a sediment tracer release site north of the SWS drop zone (figure 37 and 43-mid panel). The sediment tracer was designed to 'behave' in the same way (in terms of sediment transport) as the dredged sediment placed in the disposal site during dredge operations. If successful, the tracer would be transported (or became suspended) by waves and currents along with the dredged material. The ultimate goal of the tracer study was two-fold: 1) Identify sediment transport pathways on Peacock Spit, and 2) Verify whether dredged sediment placed within the SWS would became part of the littoral budget.

On 1 October 2006, approximately 1,200 Kg of tracer (or 150 billion tracer particles having equivalent gradation and density as MCR sand) was mixed 1:1 with MCR sand and placed on the seabed, via 120-20 Kg dissolving (starch) bags. Figure 39 (mid panel) shows the distribution of tracer release (bags) within the drop zone (bags dissolved within 10 minutes of release). Also shown are the sediment sampling activities which were performed in 4 phases during the study period (Oct 2006 – Aug 2007). On 3 October, the seabed near the tracer release site was sampled (first tracer sampling event) to verify that the tracer was on the seabed and determine of if there had been any dispersion during the preceding 2 days. The sediment tracer is identified from native sand by fluorescence illumination (see bottom panel of figure 39). Figure 40 (top panel) shows the sampling grid used to collect sediment samples for tracer detection. Results of the first tracer sampling event are shown in the bottom panel (upper caption) of figure 40. Note that the sediment tracer had been dispersed to areas beyond the deployment release points. Results of the second tracer sampling event (4 Dec 2006, 63 days after release) are shown in figure 40 (bottom panel-bottom caption) and 41 (top panel). Note the extent to which the tracer had been dispersed to the NW and northward onto Benson Beach. Based on figures 40-41, there was evidence that the tracer was mobile and transported in a north or northwest direction in line with alongshore transport at the SWS.

Results of the third and fourth tracer sampling events (April-May 2007, 120 days after release and August 2007, 180 days after release) are shown in figure 41-43. Note the extent to which the tracer had been dispersed to the NW and northward onto Benson Beach. Based on figure 45-46, there was strong and consistent evidence that the tracer was mobile and transported in a north or northwest direction in line with alongshore transport at SWS. A very small amount of transport was south towards the MCR channel: Sediment tracer was detected at one sample location during Round 3 sampling, within 1,500 ft south of the north jetty (figure 41-43).

Several conclusions can be advanced, based on the results of the sediment tracer study: It appears that sediment placed within the SWS is transported onto Peacock Spit and is incorporated into the littoral budget of WA. For some conditions, dredged mateiral placed at the SWS may be transported West then North around ebb shoal/West side of Peacock Spit (in deeper water) in line with alongshore transport. There was no evidence that indicated material placed within the SWS moved southward back into the MCR navigation channel, nor is material placed at the SWS lost to areas offshore out of the littoral budget. Longterm bathymetry change data at MCR agree with the results of the sediment tracer study: Sand is being transport off of Peacock Spit and moved northward and that material placed at the SWS feeds Peacock Spit and the littoral budget northward. Additional finding and details are described in the draft report “Sediment Tracer Study, Ocean Dredged Material Disposal Site, Mouth of Columbia River”, prepared by Moffatt and Nichol Engineers.

Table B1 . **Disposal of Dredged Material at Mouth of the Columbia River ODMDSs (1956-2006)**

(MCR & CR & Tongue Point Dredged Material Deposited at Cited Disposal Areas)

Disposal Site	A	B	C/NJ Site*	D *	E/SWS	F $*	DWS_MCR	DWC_CR***	SJ Site	G	Total cubic yards
Fiscal Year	cy	cy	cy	cy	cy	cy	cy	cy	cy	cy	cy
1956	12,096,000	1,296,000	504,000	504,000	0	0				0	14,400,000
1957	1,605,643	1,221,307	422,071	838,428	0	0				0	4,087,449
1958	6,135	2,274,704	0	326,753	0	0				0	2,607,592
1959	0	1,914,964	0	661,021	0	0				0	2,575,985
1960	0	1,927,208	0	612,636	0	0				0	2,539,844
1961	0	1,837,879	0	297,066	0	0				0	2,134,945
1962	0	2,322,256	2,838	632,618	0	0				0	2,957,712
1963	0	1,725,851	724,630	234,735	0	0				0	2,685,216
1964	0	514,900	1,459,186	683,151	0	0				0	2,657,237
1965	0	675,921	1,205,090	1,606,671	0	0				0	3,487,682
1966	0	2,010,673	29,891	2,437,451	0	215,002				0	4,693,017
1967	0	1,463,573	1,067	354,700	0	422,066				0	2,241,406
1968	0	1,919,199	0	109,592	0	0				0	2,028,791
1969	0	2,021,562	0	89,042	0	0				0	2,110,604
1970	0	1,489,795	0	3,060	0	0				0	1,492,855
1971	51,047	1,439,042	13,818	241,689	0	0				0	1,745,596
1972	12,995	2,579,688	0	287,646	0	1,886				0	2,882,215
1973	0	3,051,662	0	409,640	291,439	3,060				0	3,755,801
1974	0	994,059	0	506,711	2,168,543	29,123				0	3,698,436
1975	0	333,462	0	895,594	4,886,792	27,539				0	6,143,387
1976	2,574	1,017,100	0	758,743	4,257,150	53,250				602,895	6,691,712
1977	2,867,393	1,868,579	0	710,373	3,678,429	0				0	9,124,774
1978	3,060	187,704	0	312,635	3,925,986	0				0	4,429,385
1979	0	116,502	0	158,466	4,930,840	0				0	5,205,808
1980	11,142	118,686	0	0	2,675,722	0				0	2,805,550
1981	2,254,321	9,180	0	0	3,042,896	0				0	5,306,397
1982	971,209	12,240	0	0	3,086,514	0				0	4,069,963
1983	1,124,466	199,969	0	0	606,218	0				0	1,930,653
1984	4,060,853	3,864,247	0	0	989,600	0				0	8,914,700
1985	1,326,150	2,068,927	0	0	4,126,429	0				0	7,521,506
1986	2,037,455	3,387,376	0	0	2,926,412	0				0	8,351,243
1987	1,593,550	1,209,358	0	0	1,183,050	0				0	3,985,958
1988	1,447,240	4,533,756	0	0	478,864	0				0	6,459,860
1989	647,458	3,456,285	0	0	568,522	2,030,954				0	6,703,219
1990	2,729,358	1,119,663	0	0	507,201	0				0	4,356,222
1991	1,486,938	1,956,570	0	0	380,142	0				0	3,823,650
1992	874,700	2,888,028	0	0	796,198	0				0	4,558,926
1993	0	1,629,208	0	0	988,208	2,288,431				0	4,905,847
1994	408,924	1,002,668	0	0	397,621	1,500,407				0	3,309,620
1995	0	2,480,664	0	0	988,547	0				0	3,469,211
1996	0	1,693,145	0	0	726,336	2,205,113				0	4,624,594
1997	0	326,824	0	0	1,071,246	174,883				0	1,572,953
1998	0	0	0	0	3,444,656	820,722				0	4,265,378
1999	0	0	1,050,000	0	3,750,000	262,000				0	5,062,000
2000	0	0	504,000	0	2,896,000	465,500				0	3,865,500
2001	0	0	498,000	0	2,176,000	1,390,000				0	4,064,000
2002**	0	0	498,800	0	1,503,800	2,270,668				0	4,273,268
2003	0	0	447,000	0	2,847,000	0				0	3,294,000
2004	0	0	506,000	0	2,960,000	0	1,715,283			0	5,181,283
2005	0	0	227,000	0	2,629,000	0	1,041,000	1,318,000	34,254	0	3,931,254
2006	0	0	243,900	0	1,832,860	0	1,395,330	1,056,000		0	3,472,090
2007	0	0	200,792	0	1,724,629	0	2,305,597			0	4,231,018
Totals	37,618,611	68,160,384	8,538,083	13,672,421	75,442,850	14,160,604	6,457,210	2,374,000	34,254	602,895	224,687,312
Volume of **sediment** placed in Ocean Dredged Material Disposal Sites for 1956-2006 (cy)											***202,476,808***
Annual Avg			North Jetty		SWS	ODMDS F	MCR_DWS	CR_DWS	SJ Site	MCR Annual avg. for	
1997-2007			**463,944**		**2,439,563**	**897,296**	**1,614,303**	**1,187,000**		1990-2007	4,014,490
Note 1 : ODMDSs receive *Interim* designation in 1977 . Final designation of ODMDSs in 1986										1986-1989	6,375,070
Note 2: 1999, NJ site used. Final designation of ODMDSs in 1986 . In 2005; Sites A,B,F,E de-listed; SWS and DWS designated										1977-1985	5,478,748
Note 3: * Estuarine disposal site.; ** 43,500 cy placed on Benson Beach, *** used for Columbia River material, *$ Tongue Pt. material 1989										1956-1976	3,696,071

Table B2 Summary of SWS ODMDS utilization and dispersive properties of site.

YEAR	VOLUME PLACED IN SWS ODMDS % of MCR dredging	SPECIFICIED PLACEMENT METHOD ^ C=contractor G=government	MAXIMUM MOUND HEIGHT @ END OF DREDGING SEASON *	EFFECTIVENESS OF USING ENTIRE SW SITE TO DISPERSE DREDGED MATERIAL	TRANSPORT DURING DREDGING SEASON (CY) **	TRANSPORT DURING WINTER (CY) **	NET ANNUAL TRANSPORT OF SEDIMENT OUT OF SW SITE (CY) **
1997	1.0 MCY 68%	None (C)	**2-3 ft** peak = 5 ft	20% of the Site Was Used	-400,000 (40%)	+614,000 60%	**+214,000** 20% accumulated
1998	3.5 MCY 81%	Grid Cells (C) Uniformly (G)	**5-6 ft** peak = 6 ft	70% of the Site Was Used	-2,100,000 (60%)	-1,216,000 (35%)	**-3,315,000** (95% eroded)
1999	3.8 MCY 74%	Grid Cells(C) Uniformly(G)	**6-7 ft** Peak = 7 ft	80% of the Site Was Used	-1,520,000 (40%)	-1,091,000 (30%)	**-2,611,000** (70% eroded)
2000	2.9 MCY 75%	Grid Cells(C) Uniformly(G)	**6-8 ft** Peak = 8 ft	60% of the Site Was Used	-1,160,000 (40%)	-739,000 (25%)	**-1,899,000** (65% eroded)
2001	2.2 MCY 54%	Disposal Lanes(C) Uniformly(G)	**6-7 ft** Peak = 9 ft	70% of the Site Was Used	-1,200,000 (50%)	-1,752,000 (73%)	**-2,952,000** (123% eroded)
2002	1.5 MCY 32%	Disposal Lanes(C)	**6-7 ft** Peak = 8 ft	50% of the Site Was Used	-300,000 (20%)	-1,710,000 (113%)	**-2,010,000** (134% eroded)
2003	2.8 MCY 86%	Grid Cells (C) Grid Cells (G)	**2-4 ft** Peak = 5 ft	>90% of the Site Was Used	-900,000 (32%)	-575,000 (21%)	**-1,475,000** (52% eroded)
2004	2.9 MCY 57%	Grid Cells (C) Grid Cells (G)	**2-5 ft** Peak = 5 ft	>90% of the Site Was Used	-1,000,000 (34%)	-1,000,000 (34%)	**-2,000,000** (68% eroded)
2005	2.6 MCY 67%	Grid Cells (C) Grid Cells (G)	**2-6 ft** Peak = 7 ft	>90% of the Site Was Used	-900,000 (35%)	-1,900,000 (73%)	**-2,800,000** (107% eroded)
2006	1.8 MCY 53%	Grid Cells (C) Grid Cells (G)	**2-6 ft** Peak = 6 ft	>75% of the Site Was Used	-680,000 (37%)	-1,100,000 (60%)	**-1,780,000** (97% eroded)
2007	1.7 MCY 41%	Grid Cells (C) Grid Cells (G)	**2-6 ft** Peak = 6 ft	>75% of the Site Was Used	-510,000 (30%)	-1,530,000 (90%)	**-2,040,000** (120% eroded)
	2.8 MCY 63%	**AVERAGE VALUES**	**5-6 ft** Peak = 9 ft	**70%**	**38%**	**55%**	**93%**

^ = method used to distribute dredged material within SWS ODMDS during seasonal placement. Assigning disposal events Grid Cells is used to enhance the uniform distribution of dredged material placed through out the site; the release point of each dump is assigned to a given grid cell, the end point of the dump lies 500-1,500 ft away from the release point. Each grid cell is assigned a finite number of dumps. Disposal lanes thru the SWS were assigned a limiting elevation, above which accumulation of placed dredged material was restricted. The use of Grid Cells to minimize the vertical accumulation of dredged material placed with the SWS is considered superior to disposal lanes.
* = peak value for maximum vertical accumulation of dredged material (mound height) may have occurred before the end of the dredging season. Values reported based on accumulation with respect to baseline condition (May 1997)
** = percentage of dredged material transported (out of SWS ODMDS) is based on the volume "placed" during a given year. Transport greater than 100% indicates that the SWS experienced net erosion. 1997 not included in winter and net dispersal statistics due to El Nino related deposition that occurred within western half of the site.

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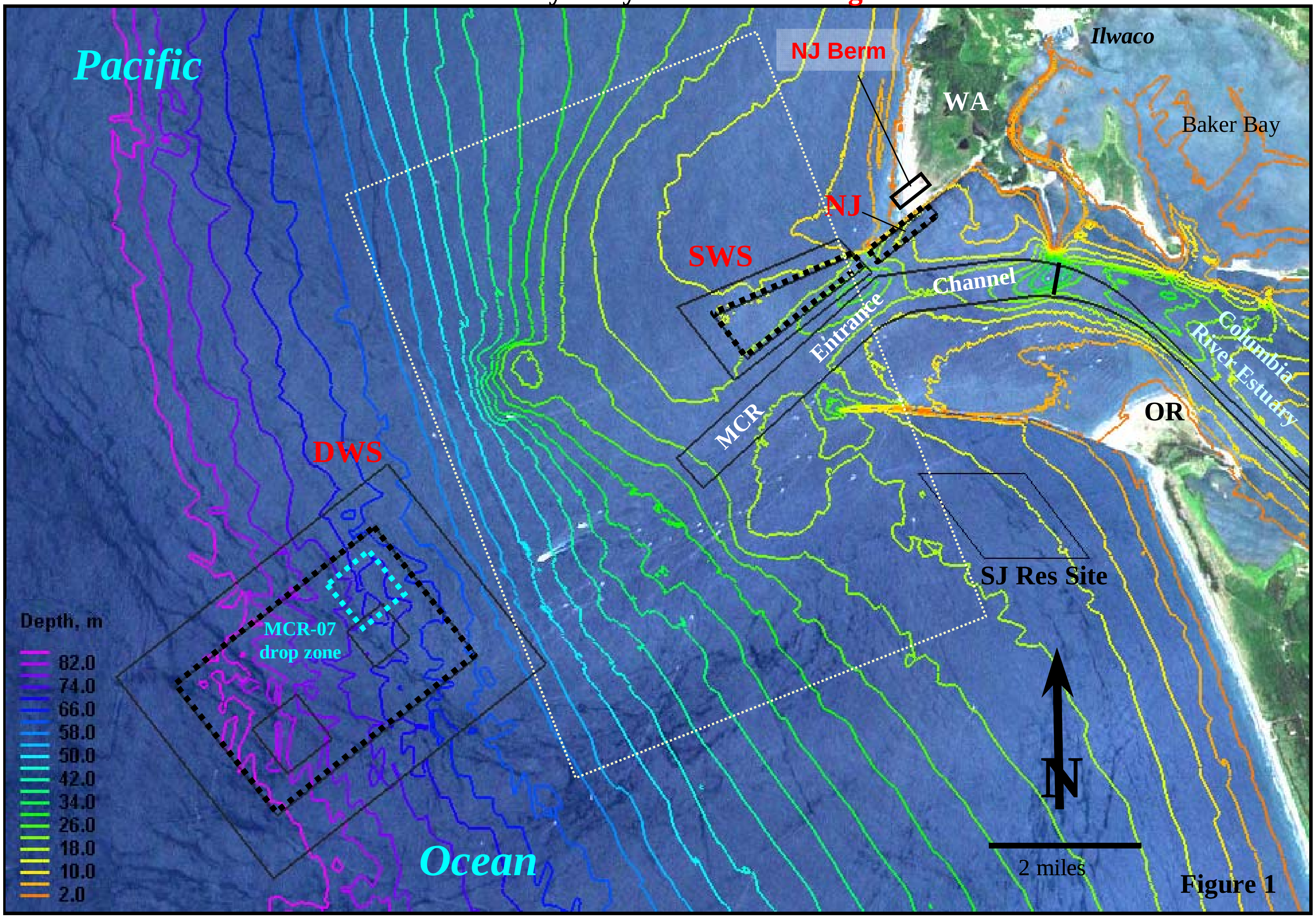
Mouth of the Columbia River - Bathymetry and 2008 Dredged Material Placement Sites



DWS= Deep Water Site, 102 MPRSA
SWS= Shallow Water Site, 102 MPRSA
NJ = North Jetty disposal site, 404 CWA
White Box = Bathymetry change shown in Fig 34
SJ Res. Site = South Jetty research site
NJ Berm = North Jetty protection site, fig 1a

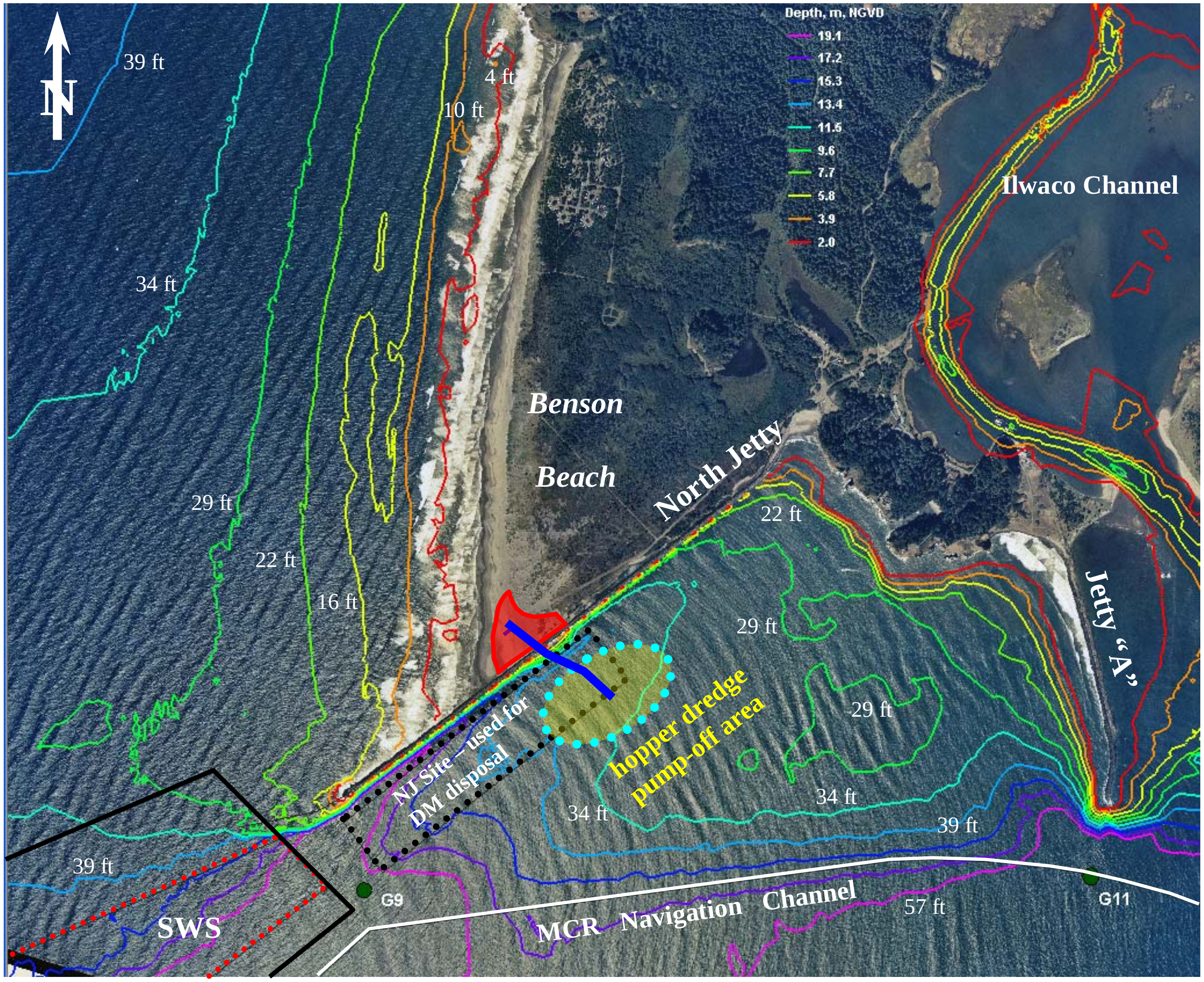


Figure 1a

NJ Berm
Upland Disposal Site

Approximately 100,000 cy of MCR dredged sand will be placed at the "NJ Berm" site. The dredged sand will be pumped ahsore from a hopper dredge during a 3 week period, occurring within 15 July – 15 Sept 2008.

The NJ Berm placement area extends along the North Jetty for approximately 1,000 ft, from +7 ft MLLW to +20 ft MLLW. The placement area extends northward (from the north jetty) for approximately 900 ft.

Scale

1,000 ft

0 ft NAVD =
+0.2 ft MLLW

= Potential pump-ashore pipeline location

= proposed 2008 placement area for NJ BERM site (North Jetty berm repair)

Contour data (ft NAVD) are based on 1999 -2003, contour elevations east of north jetty are approximate.

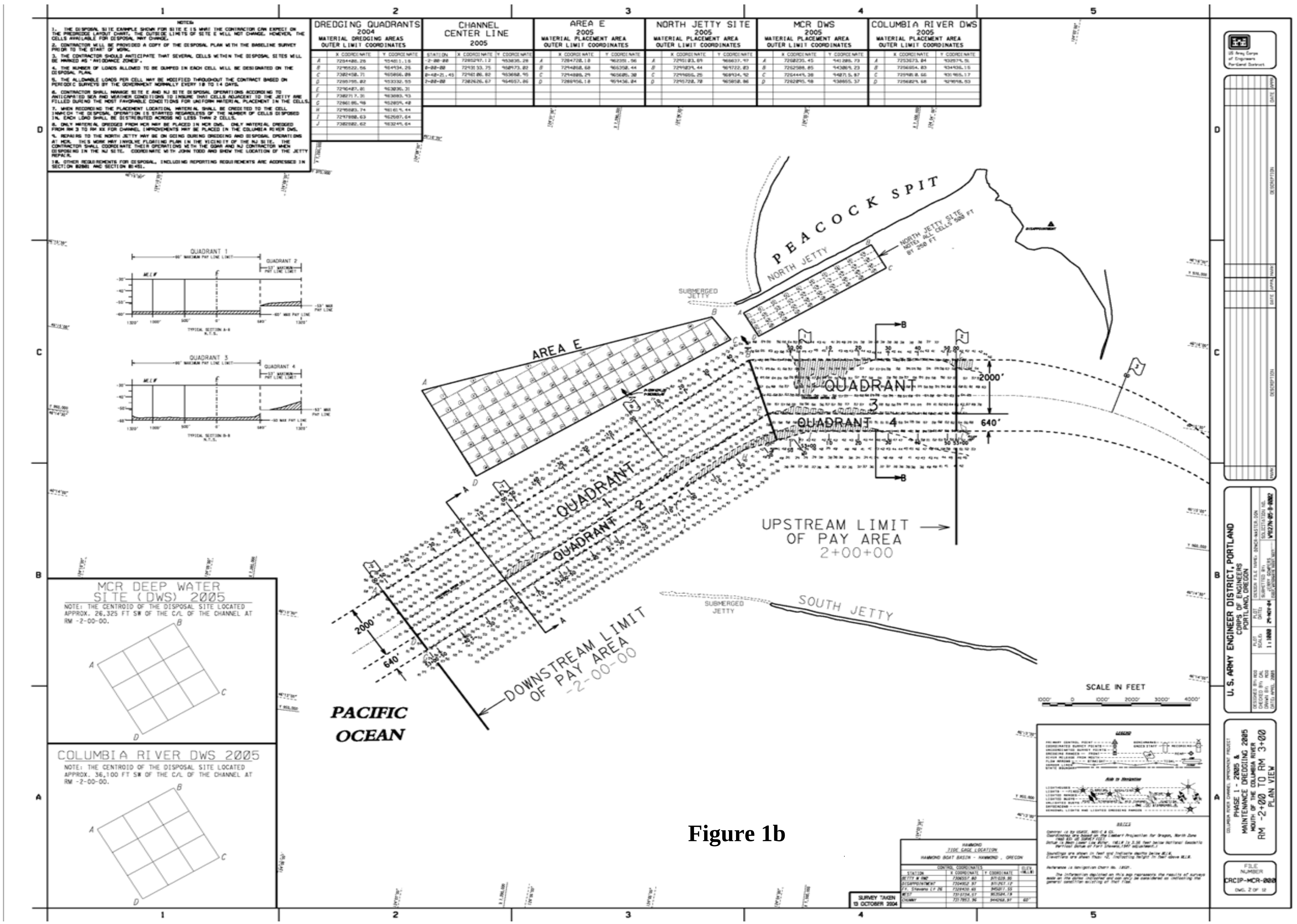

DREDGING QUADRANTS
CHANNEL CENTER LINE
AREA E
NORTH JETTY SITE
MCR DWS
COLUMBIA RIVER DWS
PEACOCK SPIT
NORTH JETTY
SUBMERGED JETTY
AREA E
QUADRANT 1
QUADRANT 2
QUADRANT 3
QUADRANT 4
2000'
640'
UPSTREAM LIMIT OF PAY AREA
2+00+00
DOWNSTREAM LIMIT OF PAY AREA
-2-00-00
SOUTH JETTY
PACIFIC OCEAN
MCR DEEP WATER SITE (DWS) 2005
COLUMBIA RIVER DWS 2005
SCALE IN FEET
U. S. ARMY ENGINEER DISTRICT, PORTLAND

Figure 1b

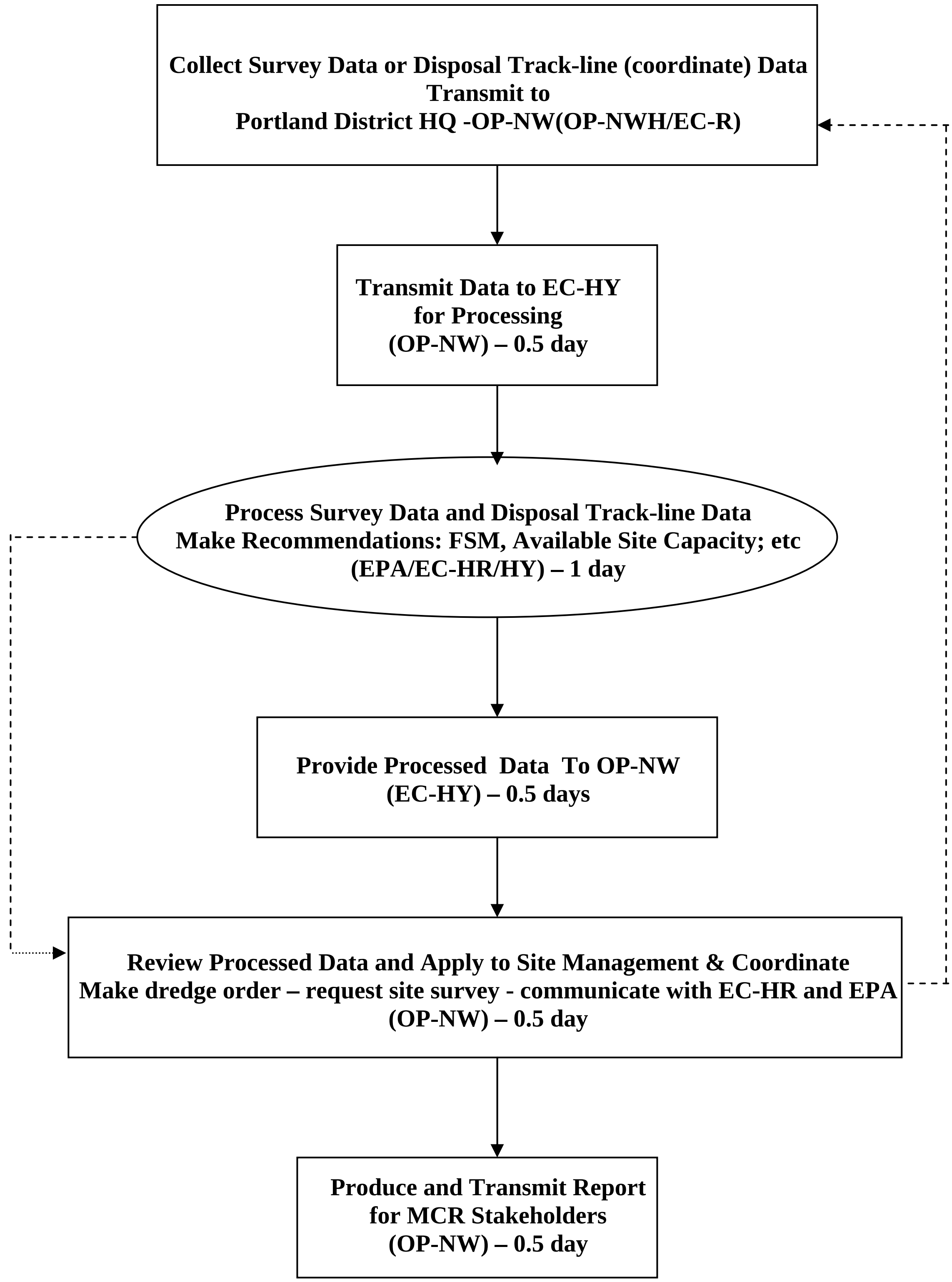


Figure 2. Flow diagram describing the procedure of processing monitoring data and using the processed data to manage disposal site capacity, at a frequency of 1 week or greater. Offices shown in () are assigned responsibility for task; expected duration of task is specified. FSM = Frequency for Site Monitoring.

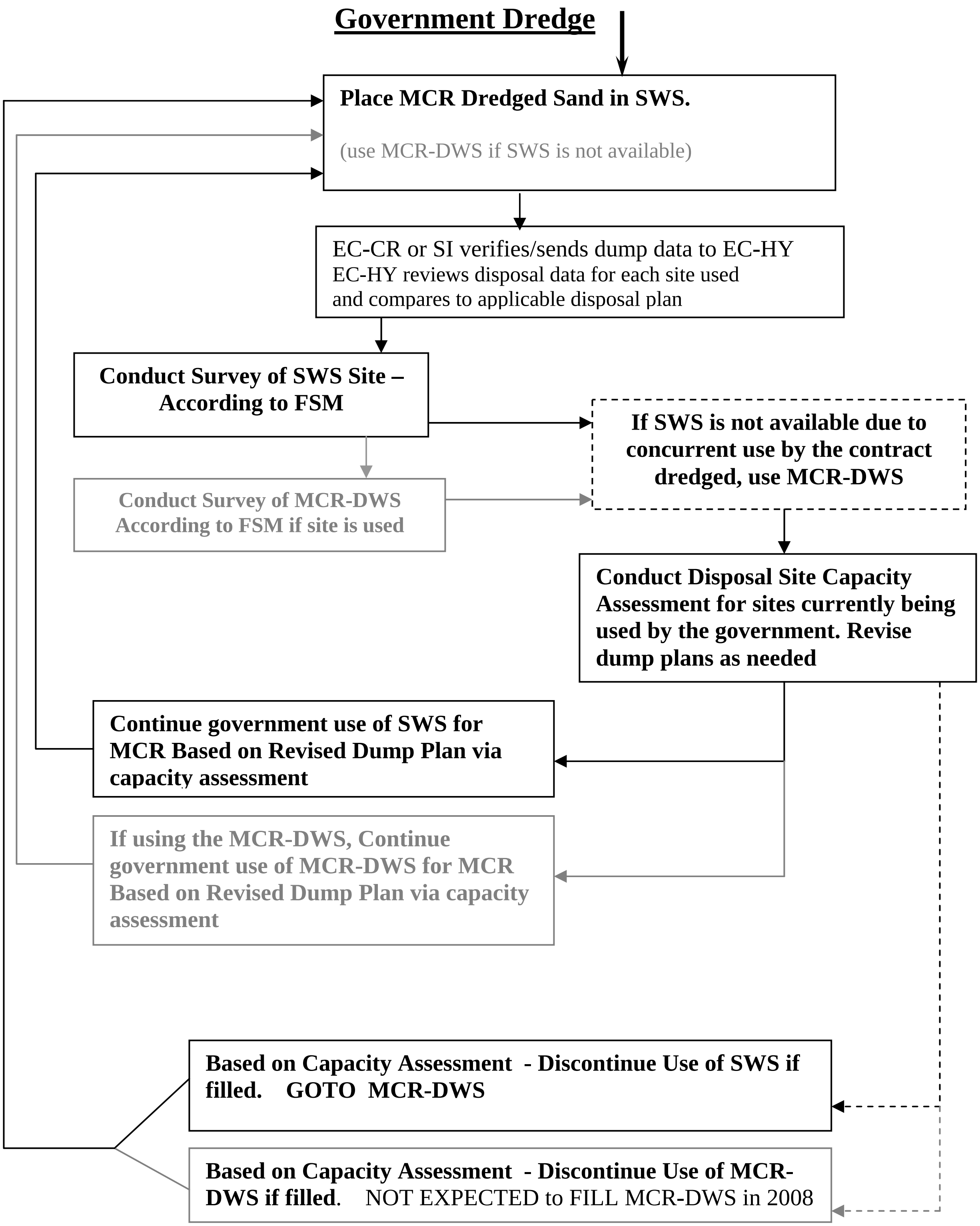


Figure 3a. Flow Diagram describing Action events for government dredge *Essayons* during dredging-disposal at MCR for 2008.

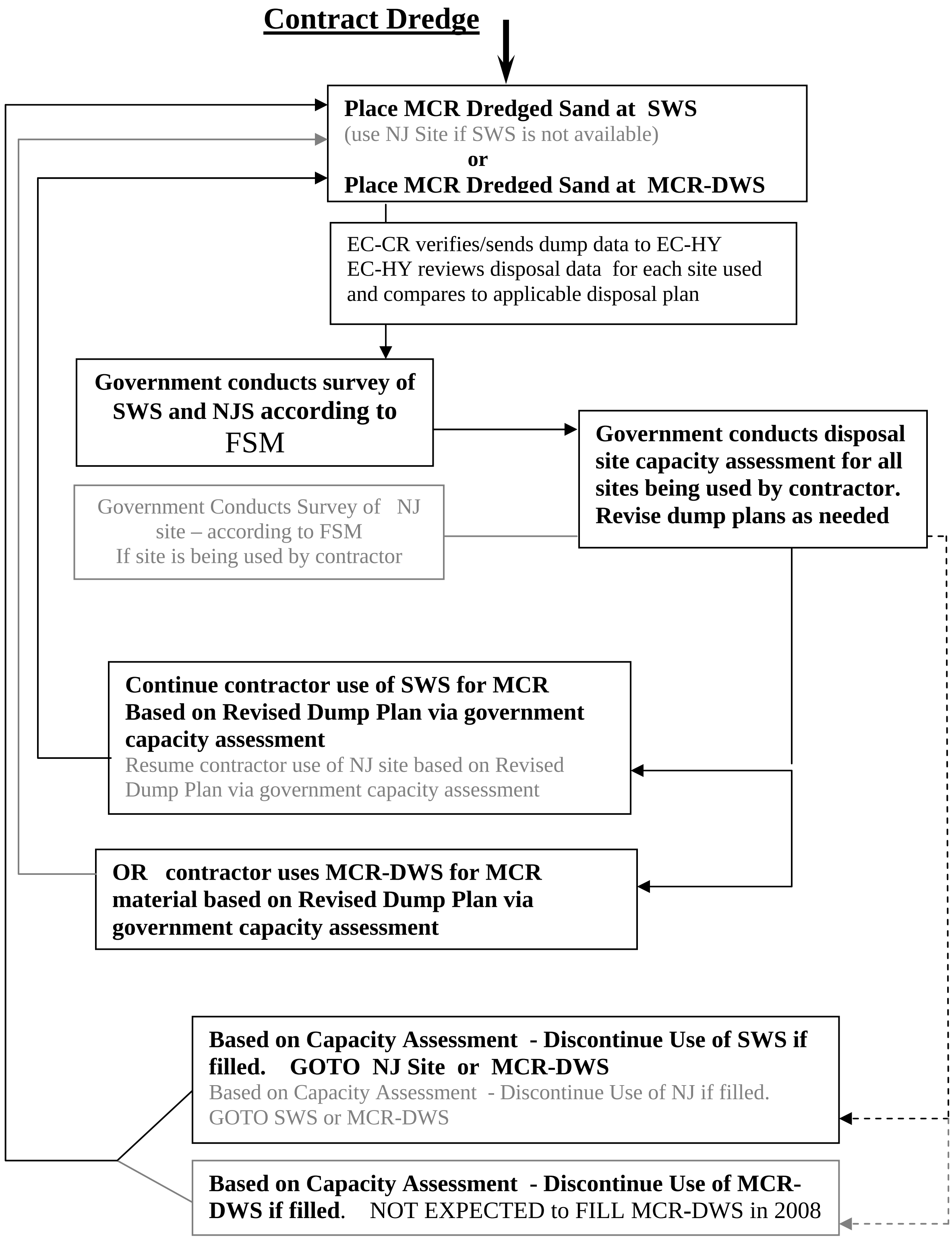


Figure 3b. Flow Diagram describing Action events for contract dredge during dredging-disposal at MCR for 2008.

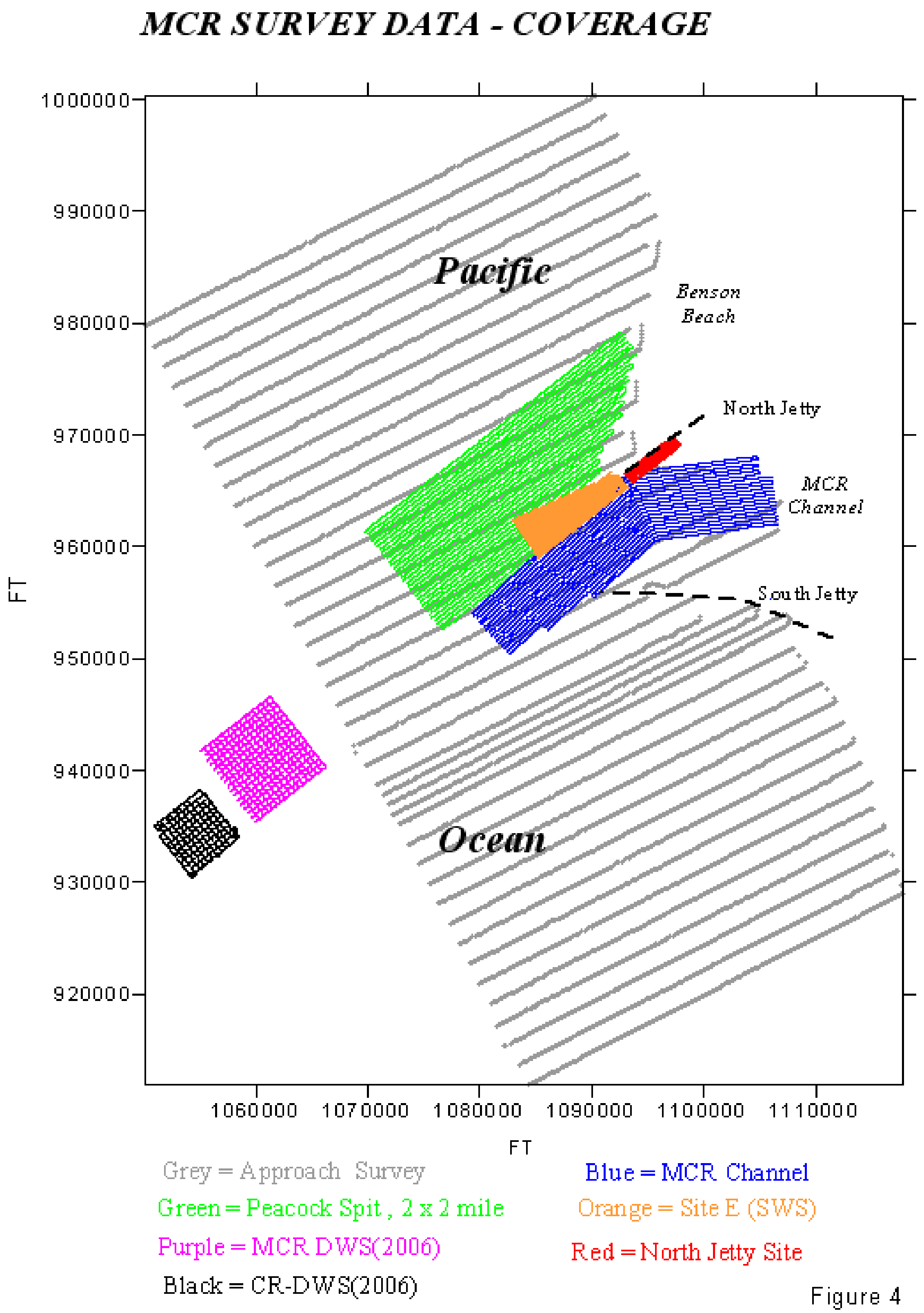

MCR SURVEY DATA - COVERAGE
1000000
990000
980000
970000
960000
950000
940000
930000
920000
FT
Pacific
Benson Beach
North Jetty
MCR Channel
South Jetty
Ocean
1060000
1070000
1080000
1090000
1100000
1110000
FT
Grey = Approach Survey
Blue = MCR Channel
Green = Peacock Spit , 2 x 2 mile
Orange = Site E (SWS)
Purple = MCR DWS(2006)
Red = North Jetty Site
Black = CR-DWS(2006)

Figure 4

Site Use Sequence = Atl 1:
Once the dredge has placed the specified number of dumps in a cell, that cell shall become a Limited Capacity Zone

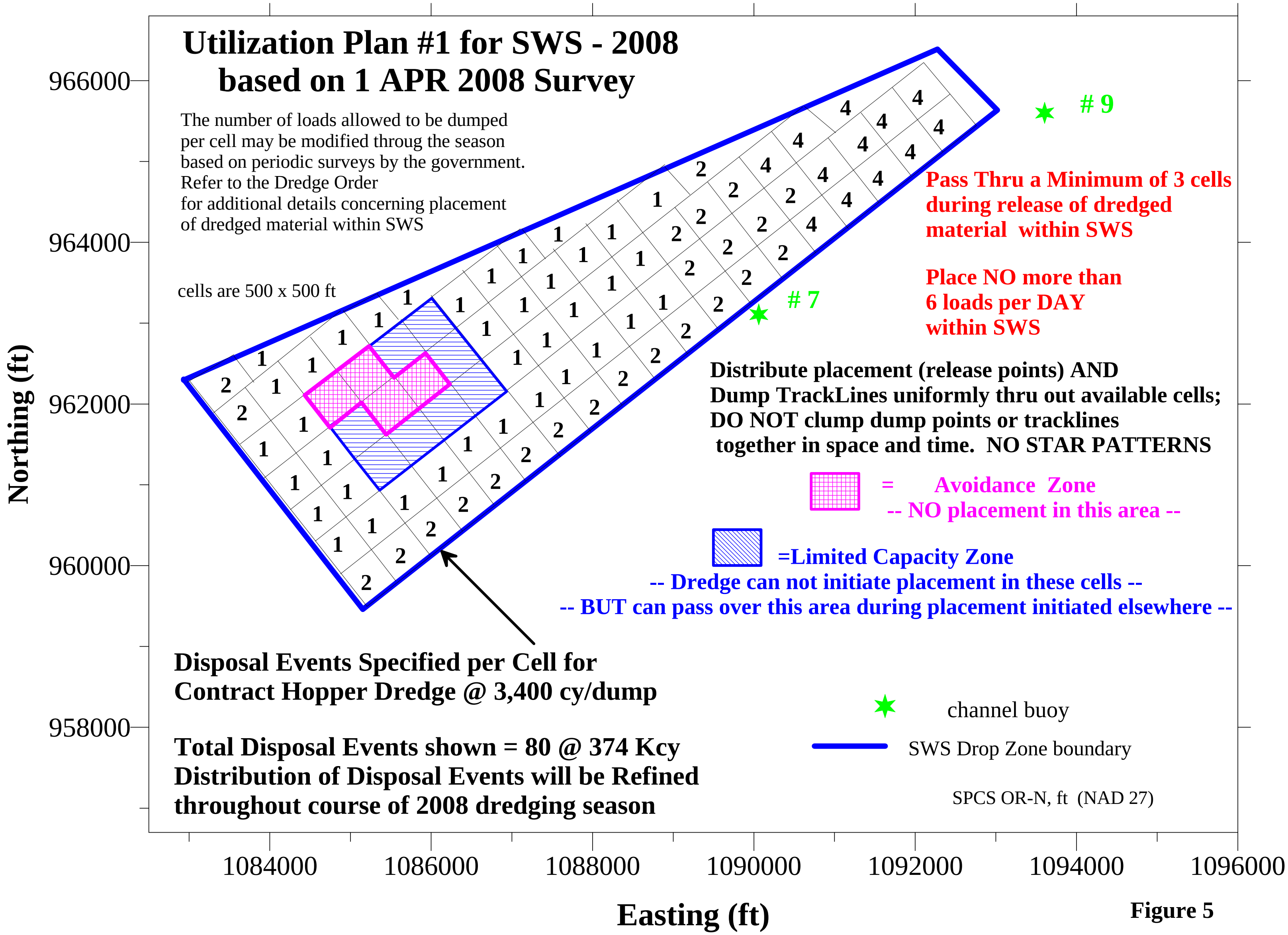


Figure 5

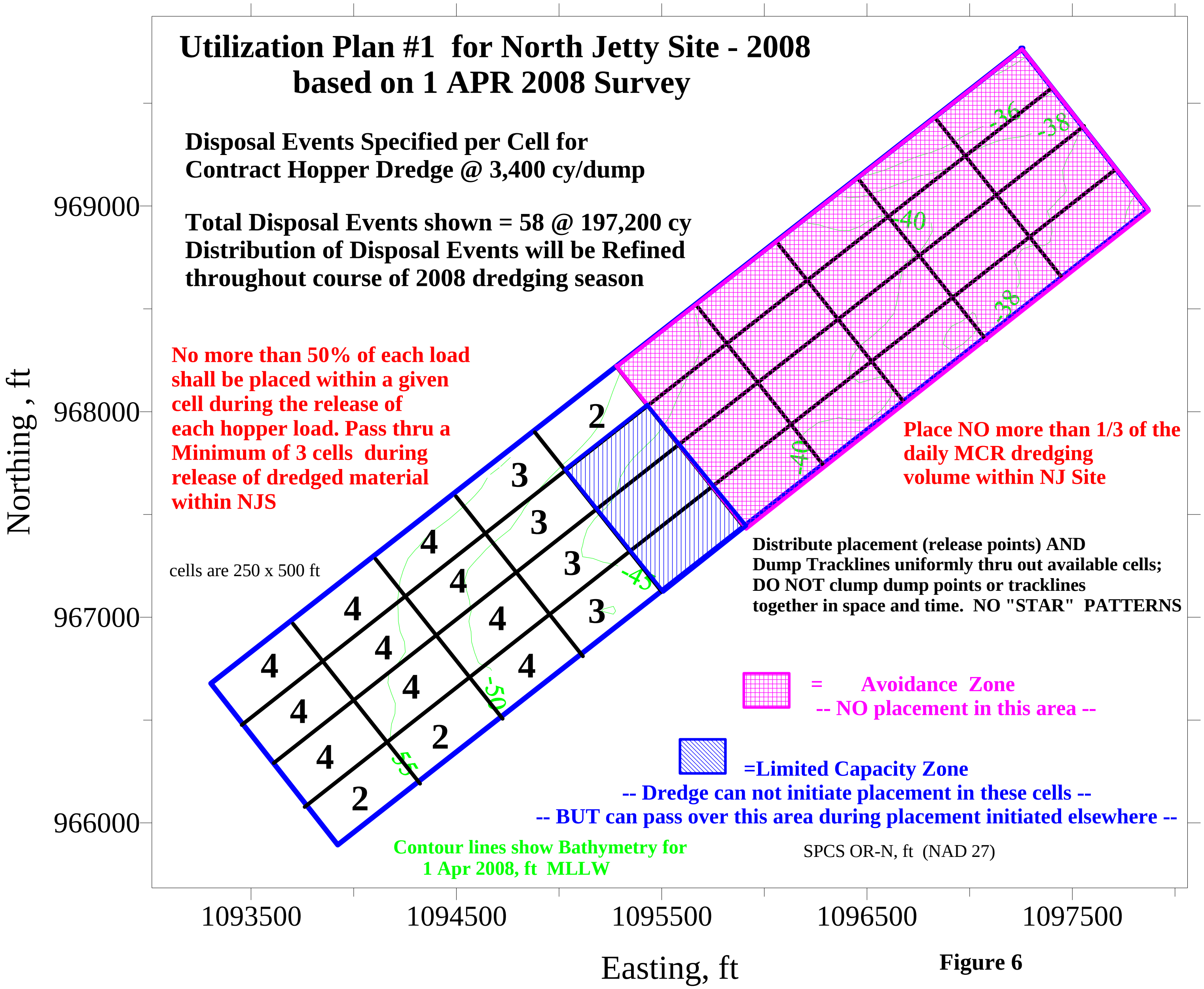

Utilization Plan #1 for North Jetty Site - 2008
based on 1 APR 2008 Survey
Disposal Events Specified per Cell for
Contract Hopper Dredge @ 3,400 cy/dump
Total Disposal Events shown = 58 @ 197,200 cy
Distribution of Disposal Events will be Refined
throughout course of 2008 dredging season
No more than 50% of each load shall be placed within a given cell during the release of each hopper load. Pass thru a Minimum of 3 cells during release of dredged material within NJS
cells are 250 x 500 ft
Place NO more than 1/3 of the daily MCR dredging volume within NJ Site
Distribute placement (release points) AND Dump Tracklines uniformly thru out available cells; DO NOT clump dump points or tracklines together in space and time. NO "STAR" PATTERNS
= Avoidance Zone
-- NO placement in this area --
=Limited Capacity Zone
-- Dredge can not initiate placement in these cells --
-- BUT can pass over this area during placement initiated elsewhere --
Contour lines show Bathymetry for 1 Apr 2008, ft MLLW
SPCS OR-N, ft (NAD 27)
Northing , ft
Easting, ft
969000
968000
967000
966000
1093500
1094500
1095500
1096500
1097500

Figure 6

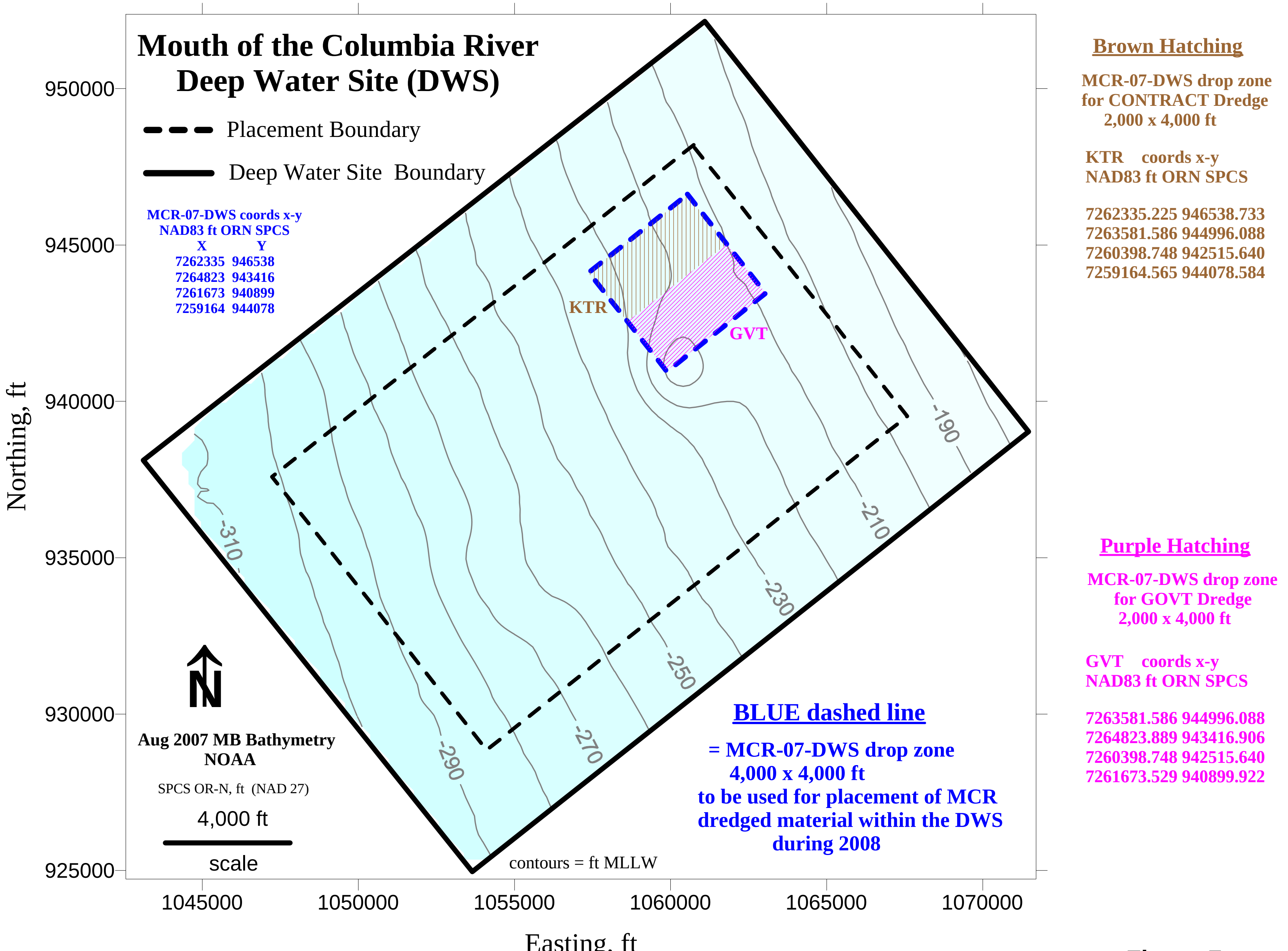
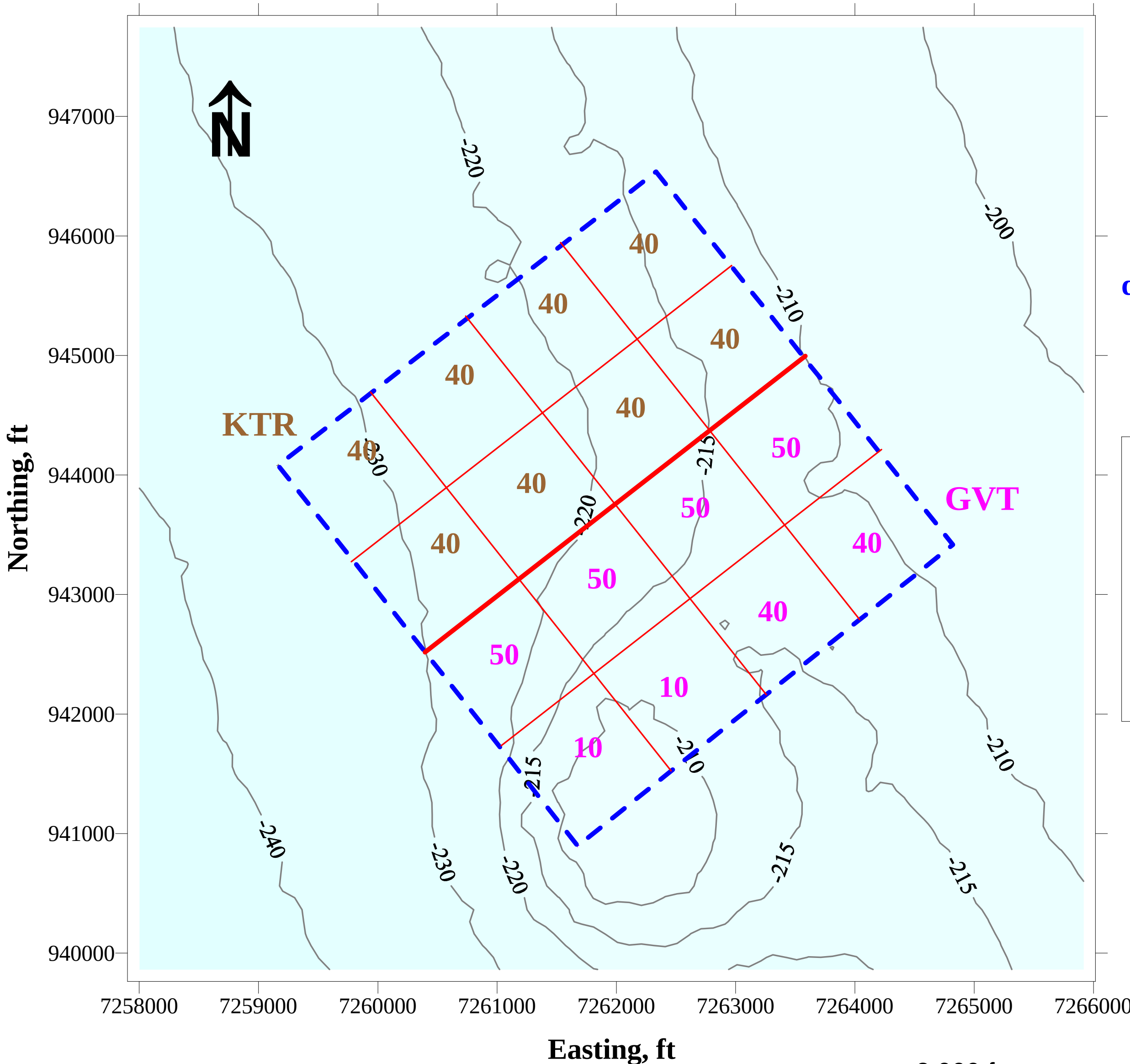

Mouth of the Columbia River
Deep Water Site (DWS)
Placement Boundary
Deep Water Site Boundary
MCR-07-DWS coords x-y
NAD83 ft ORN SPCS
X Y
7262335 946538
7264823 943416
7261673 940899
7259164 944078
KTR
GVT
-190
-210
-230
-250
-270
-290
-310
Aug 2007 MB Bathymetry
NOAA
SPCS OR-N, ft (NAD 27)
4,000 ft
scale
contours = ft MLLW
BLUE dashed line
= MCR-07-DWS drop zone
4,000 x 4,000 ft
to be used for placement of MCR
dredged material within the DWS
during 2008
Northing, ft
950000
945000
940000
935000
930000
925000
Easting, ft
1045000
1050000
1055000
1060000
1065000
1070000
Brown Hatching
MCR-07-DWS drop zone
for CONTRACT Dredge
2,000 x 4,000 ft
KTR coords x-y
NAD83 ft ORN SPCS
7262335.225 946538.733
7263581.586 944996.088
7260398.748 942515.640
7259164.565 944078.584
Purple Hatching
MCR-07-DWS drop zone
for GOVT Dredge
2,000 x 4,000 ft
GVT coords x-y
NAD83 ft ORN SPCS
7263581.586 944996.088
7264823.889 943416.906
7260398.748 942515.640
7261673.529 940899.922

Figure 7



AUG 2007 bathymetry - NOAA

coordinate system: SPCS OR, N ft NAD83

2,000 ft
scale

Mouth of the Columbia River Deep Water Site (MCR-07-DWS)

Utilization Plan #1 for MCR DWS: 2008

dashed blue line = "MCR-07-DWS" Site drop zone is 4,000 x 4,000 ft

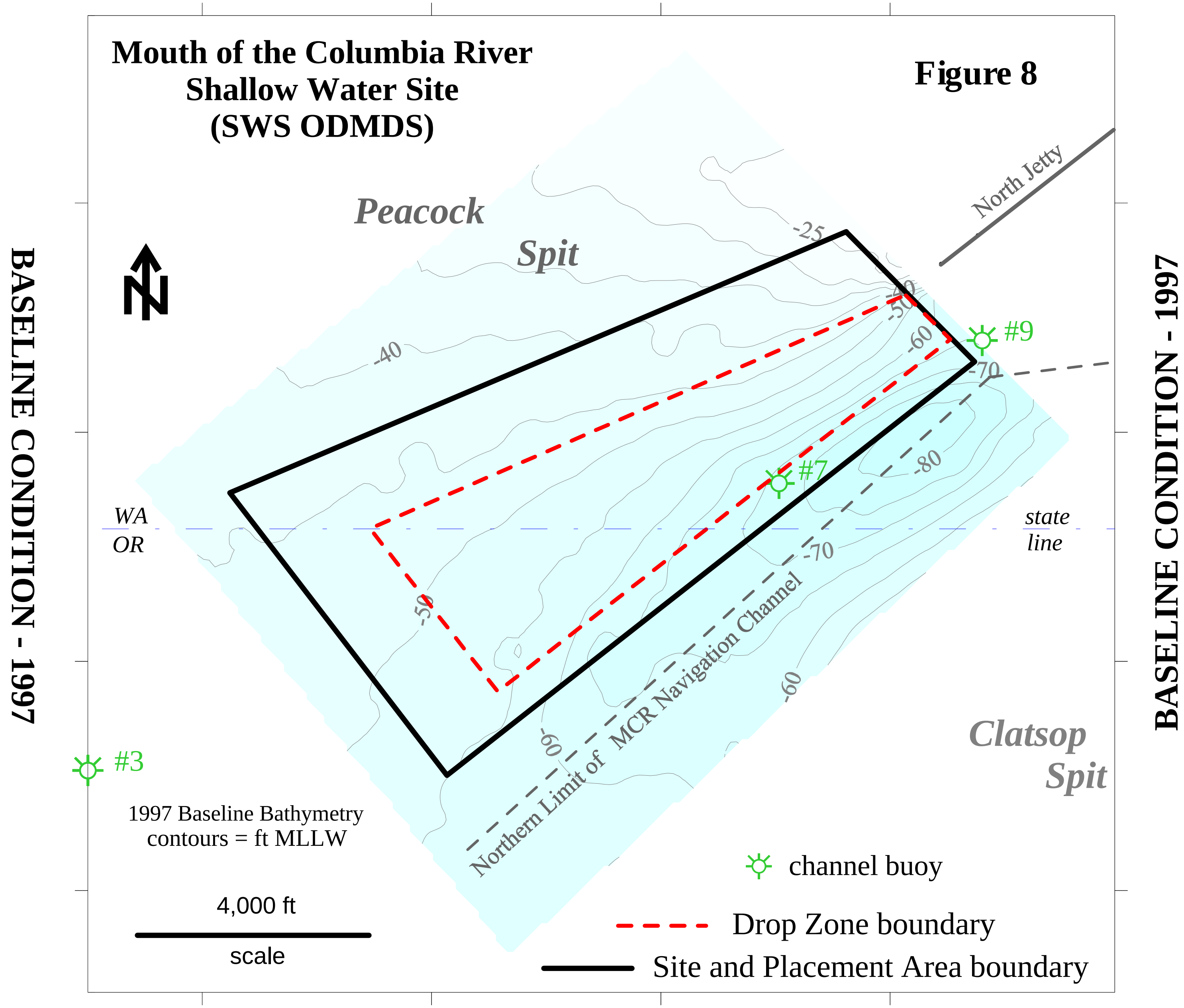
cells = 1,000 ft x 1,000 ft

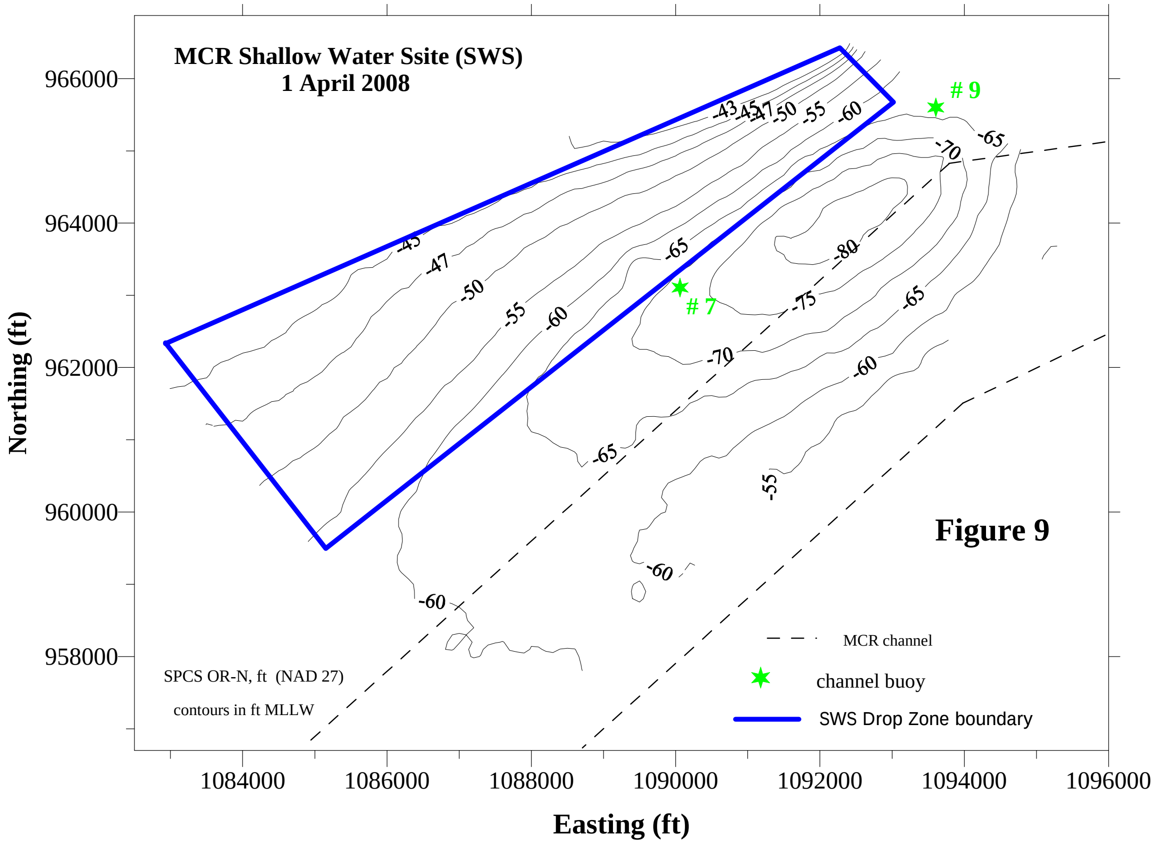
BROWN cell assignments = 200 loads CONTRACT (KTR) dredge loads/cell at 3,400 cy/load = 1.1 MCY

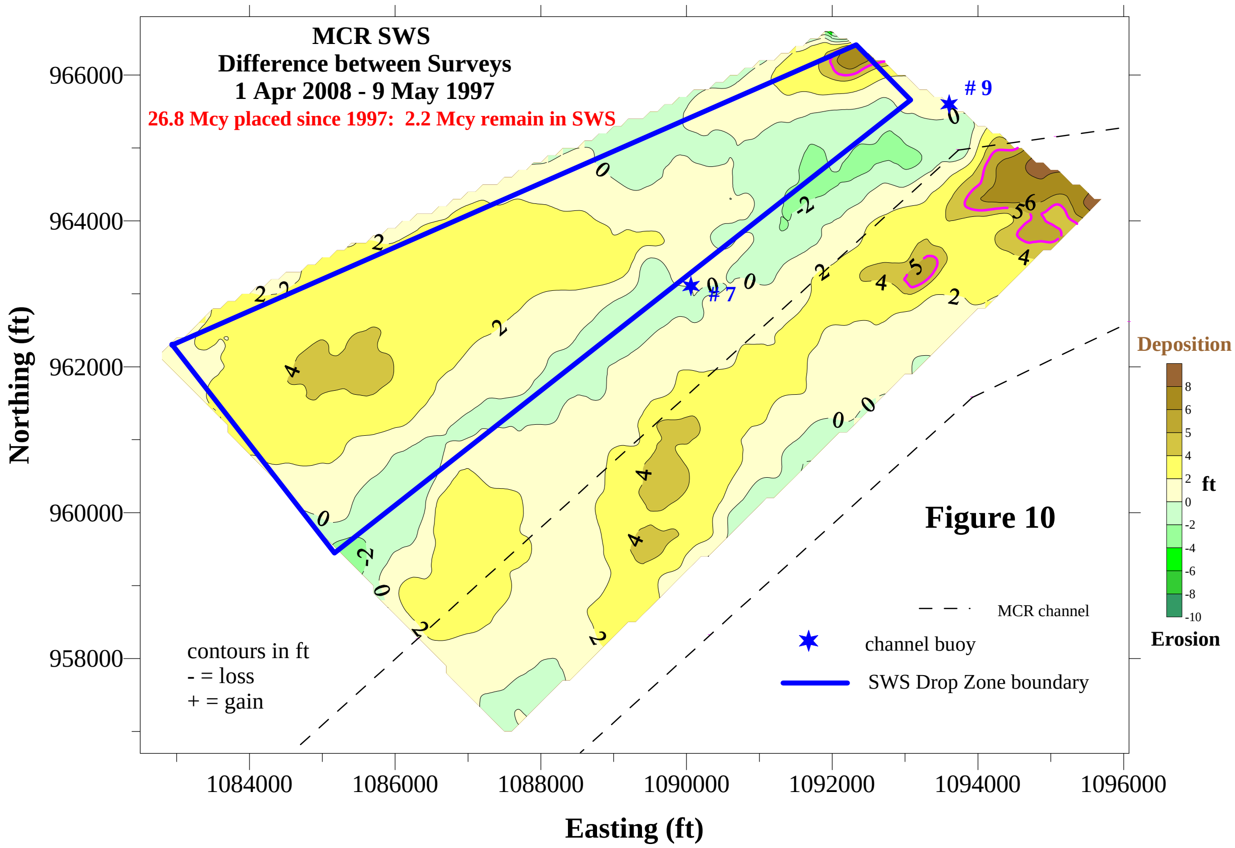
PURPLE cell assignments = 300 loads GOVERNMENT (GVT) dredge oads/cell at 5,000 cy/load = 1.5 MCY

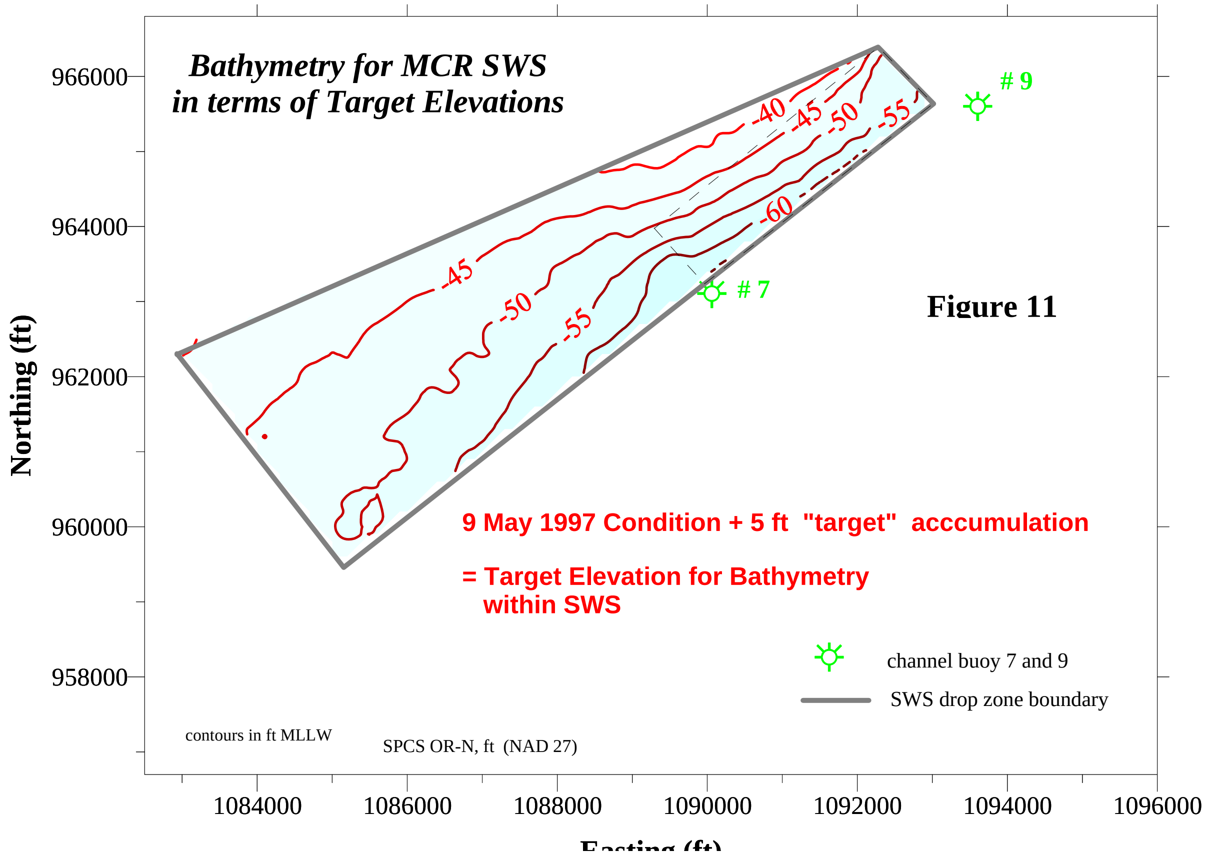
Red Lines = grid (cells) used to control the placement of dredged material within the MCR DWS area - 1,000 x 1,000 ft ea.

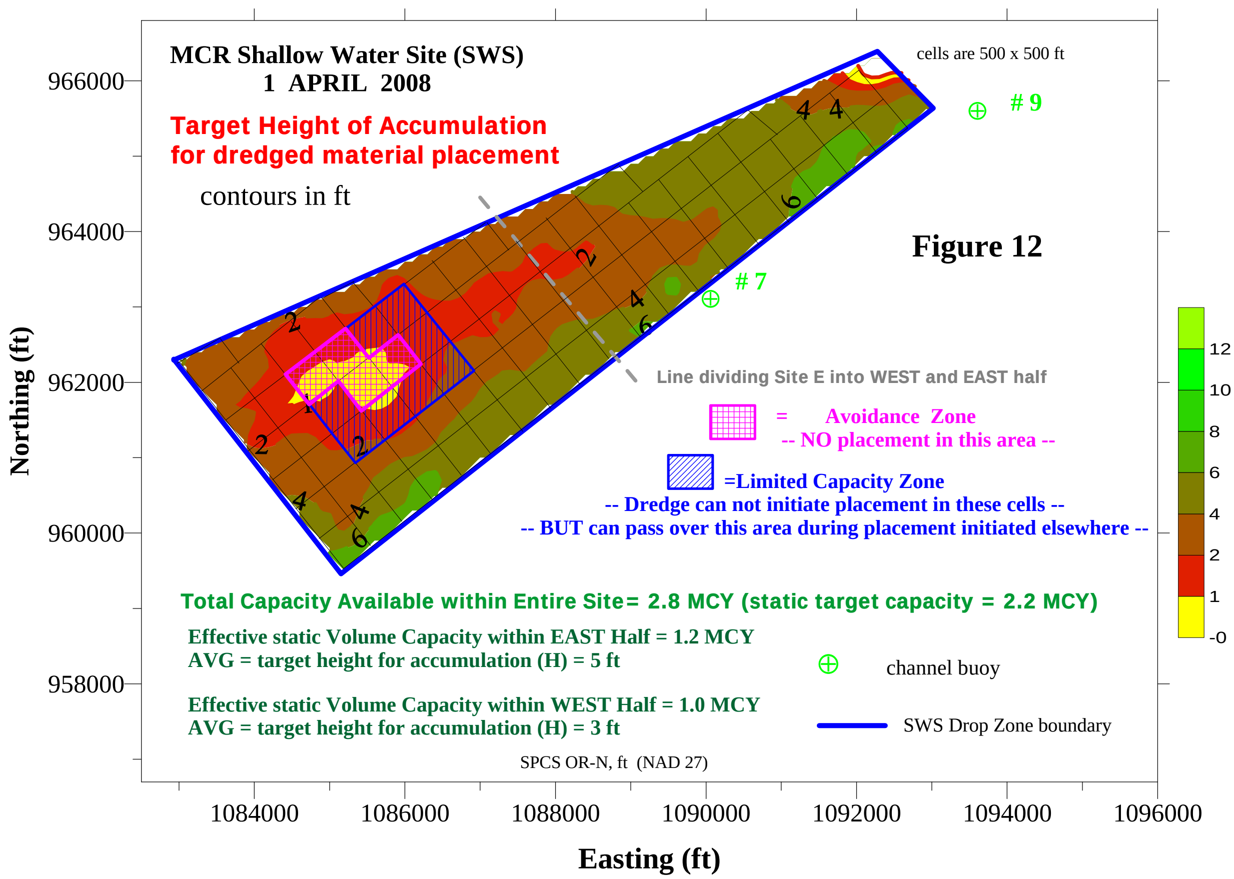
Figure 7a


Mouth of the Columbia River
Shallow Water Site
(SWS ODMDS)
Figure 8
BASELINE CONDITION - 1997
BASELINE CONDITION - 1997
Peacock
Spit
North Jetty
Clatsop
Spit
WA
OR
state
line
Northern Limit of MCR Navigation Channel
#9
#7
#3
-25
-40
-50
-60
-70
-80
1997 Baseline Bathymetry
contours = ft MLLW
4,000 ft
scale
channel buoy
Drop Zone boundary
Site and Placement Area boundary


MCR Shallow Water Ssite (SWS)
1 April 2008
Figure 9
Northing (ft)
Easting (ft)
SPCS OR-N, ft (NAD 27)
contours in ft MLLW
MCR channel
channel buoy
SWS Drop Zone boundary
9
7


MCR SWS
Difference between Surveys
1 Apr 2008 - 9 May 1997
26.8 Mcy placed since 1997: 2.2 Mcy remain in SWS
Figure 10
Northing (ft)
Easting (ft)
contours in ft
- = loss
+ = gain
MCR channel
channel buoy
SWS Drop Zone boundary
Deposition
Erosion
ft
9
7


Bathymetry for MCR SWS
in terms of Target Elevations
-40
-45
-50
-55
-60
9
7
Figure 11
9 May 1997 Condition + 5 ft "target" acccumulation
= Target Elevation for Bathymetry within SWS
channel buoy 7 and 9
SWS drop zone boundary
contours in ft MLLW
SPCS OR-N, ft (NAD 27)
Northing (ft)
966000
964000
962000
960000
958000
1084000
1086000
1088000
1090000
1092000
1094000
1096000
Easting (ft)


MCR Shallow Water Site (SWS)
1 APRIL 2008
Target Height of Accumulation
for dredged material placement
contours in ft
cells are 500 x 500 ft
9
7
Figure 12
Line dividing Site E into WEST and EAST half
= Avoidance Zone
-- NO placement in this area --
=Limited Capacity Zone
-- Dredge can not initiate placement in these cells --
-- BUT can pass over this area during placement initiated elsewhere --
Total Capacity Available within Entire Site= 2.8 MCY (static target capacity = 2.2 MCY)
Effective static Volume Capacity within EAST Half = 1.2 MCY
AVG = target height for accumulation (H) = 5 ft
Effective static Volume Capacity within WEST Half = 1.0 MCY
AVG = target height for accumulation (H) = 3 ft
channel buoy
SWS Drop Zone boundary
SPCS OR-N, ft (NAD 27)
12
10
8
6
4
2
1
-0
Northing (ft)
966000
964000
962000
960000
958000
1084000
1086000
1088000
1090000
1092000
1094000
1096000
Easting (ft)

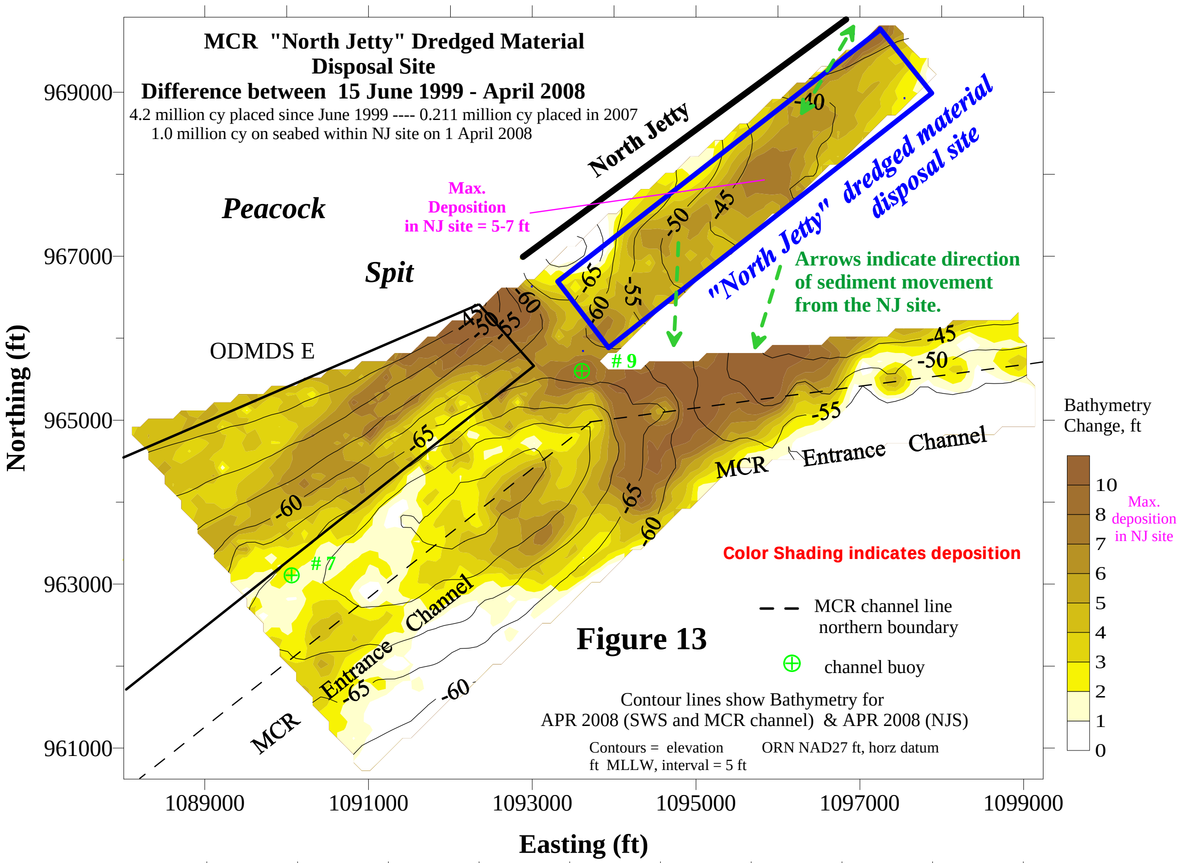


Figure 13

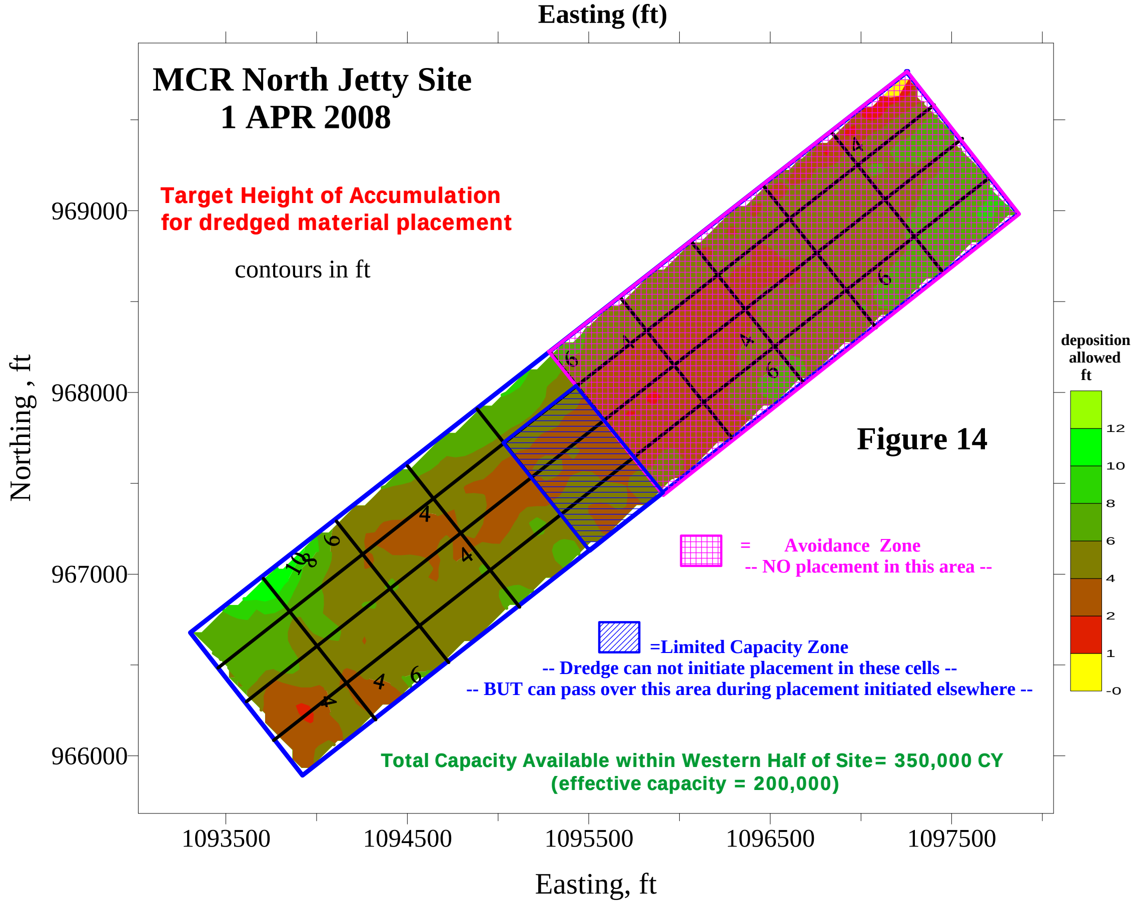
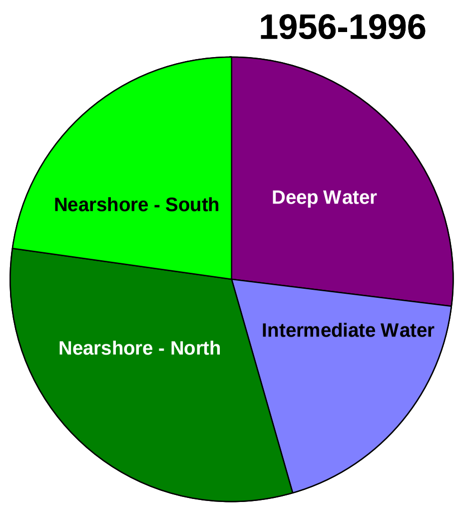
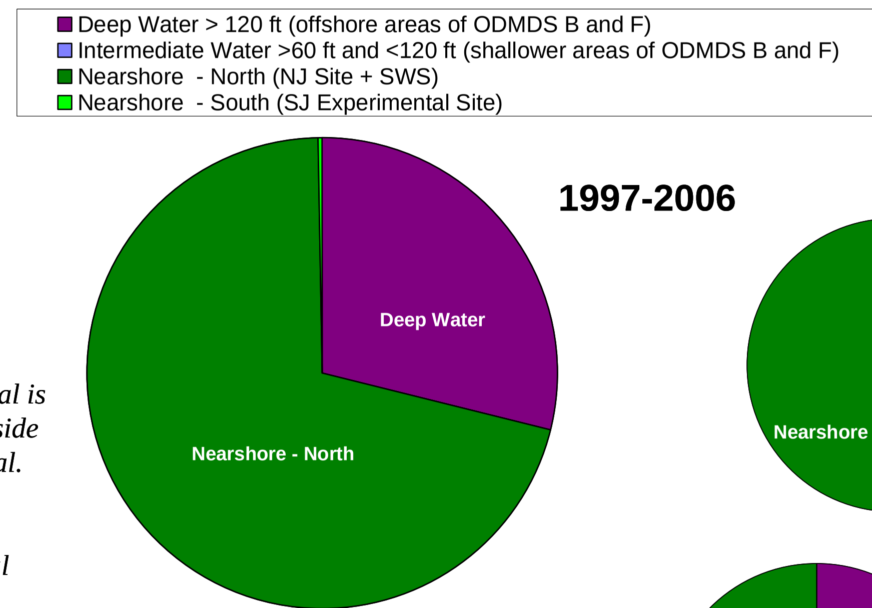
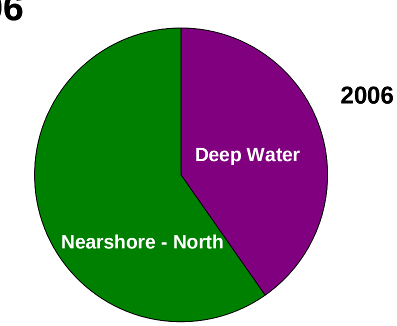


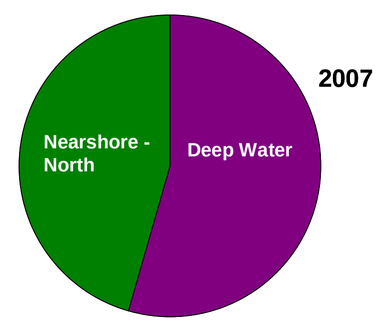
Figure 14

MCR Dredged Material Placement through time (includes material from Tongue Pt-1992 and Lower Columbia River-2005/06). During 1956-96, about 2/3's of dredged material was placed in water less than 60ft (green areas) and was almost equally distributed north and south of MCR. During 1997-2006, ~70% of MCR material dredged was placed nearshore, with almost all nearshore disposal limited to the north side (WA) of MCR. In 2006, more material was placed in water deeper than 60 ft (offshore) than the previous 10 years, and all material which was placed within the nearshore occurred along north side of MCR. Note that more material was placed in offshore during 2007, than was in 2006.







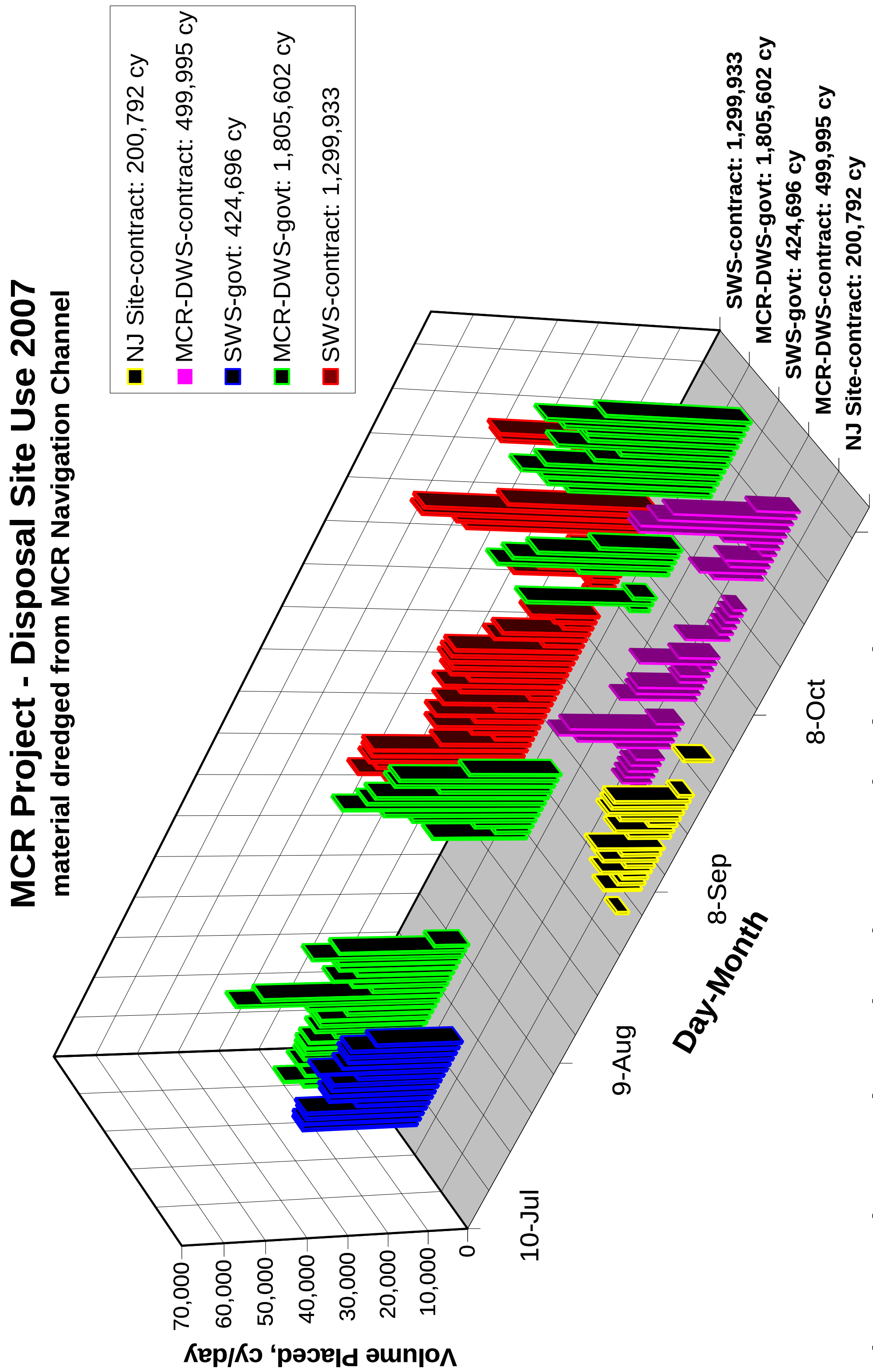


Present Condition = MCR dredged material is being placed offshore and the south (OR) side of the inlet is receiving no dredged material.

Implications = Less MCR dredged sand is being (re)introduced into the inlet's littoral budget and the south side of the inlet has become "sediment starved".

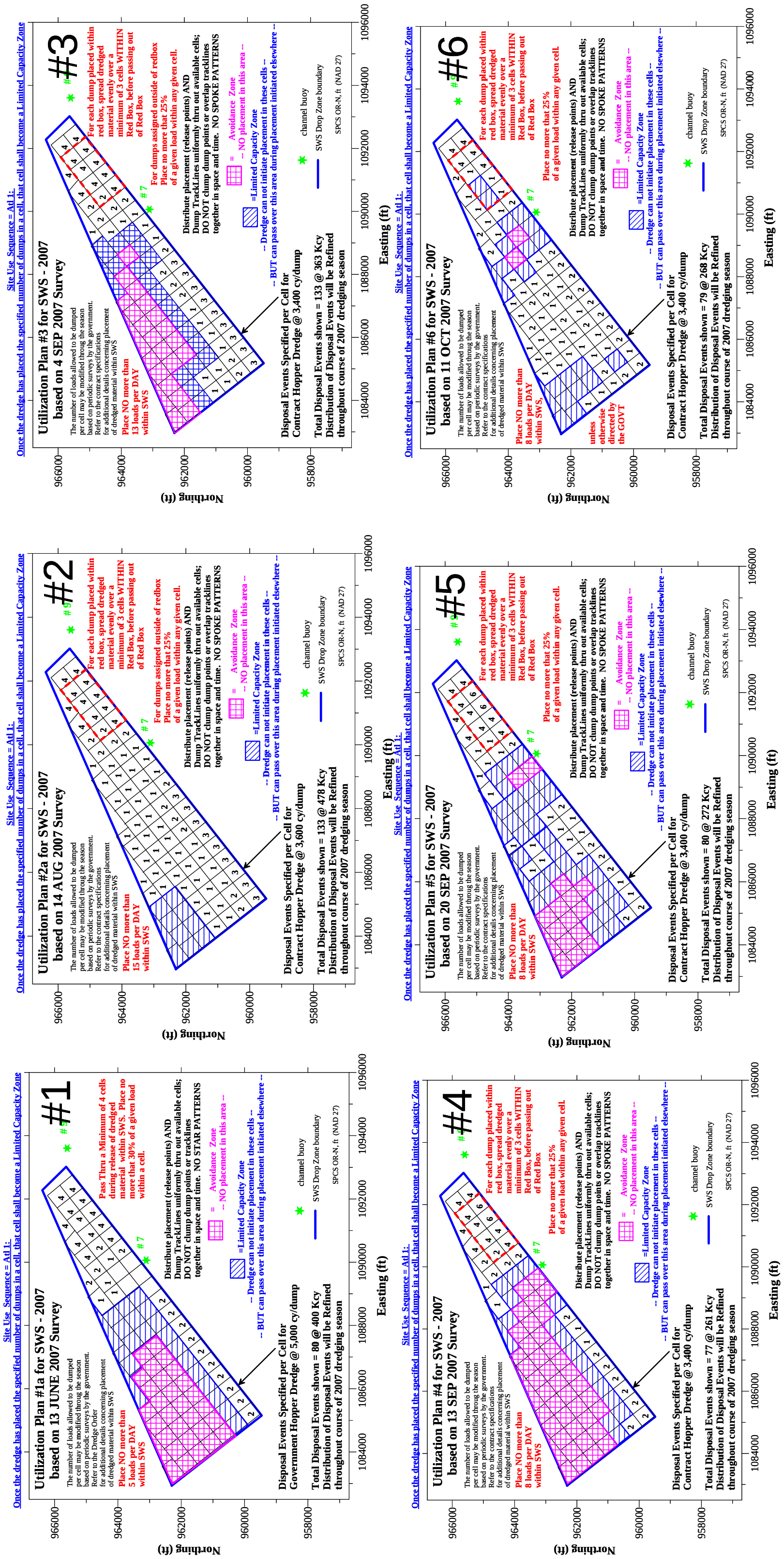
FUTURE: Avoid deep water placement of MCR dredged material (sand). Improve the balancing the MCR littoral sediment budget by achieving judicious distribution of nearshore placement north (WA) and south (OR) of MCR.

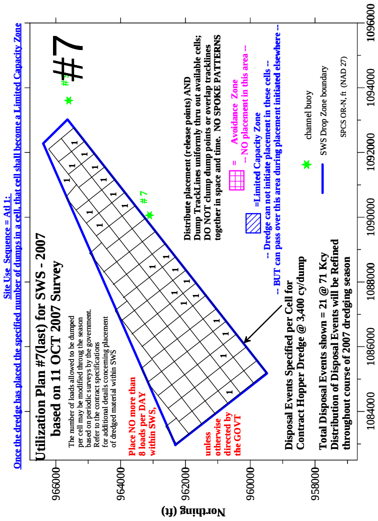
Figure 15



Special care was taken to avoid over-utilizing the MCR nearshore disposal sites - SWS and NJS by: A) having each dredge distributing dredged material placement at multiple disposal areas and, B) avoid having two dredges concurrently utilizing the same disposal site. When the contract dredge was working at MCR, dredged material was placed within the NJS, SWS, and MCR-DWS. When the govt dredge was working at MCR, dredged material was placed within the SWS and MCR-DWS.

Figure 16





7 disposal plans were used to guide dredged material placement within the SWS during 2007. Plan #1 applied to the government dredge for 424 K cubic yards, during 15 – 28 July. Plans #2-7 applied to the contract dredge for 1.3 M cubic yards during 30 Aug – 28 Oct.

Figure 17

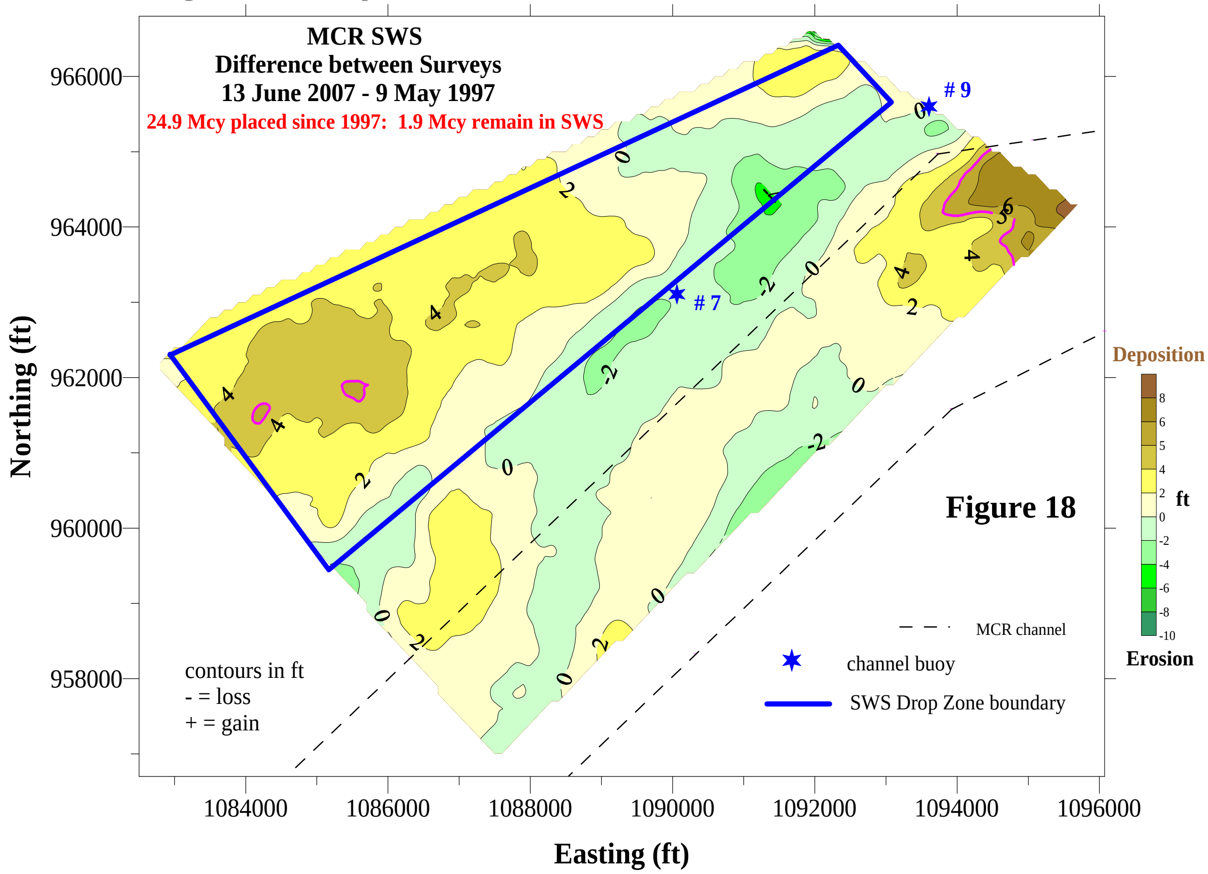


Figure 18

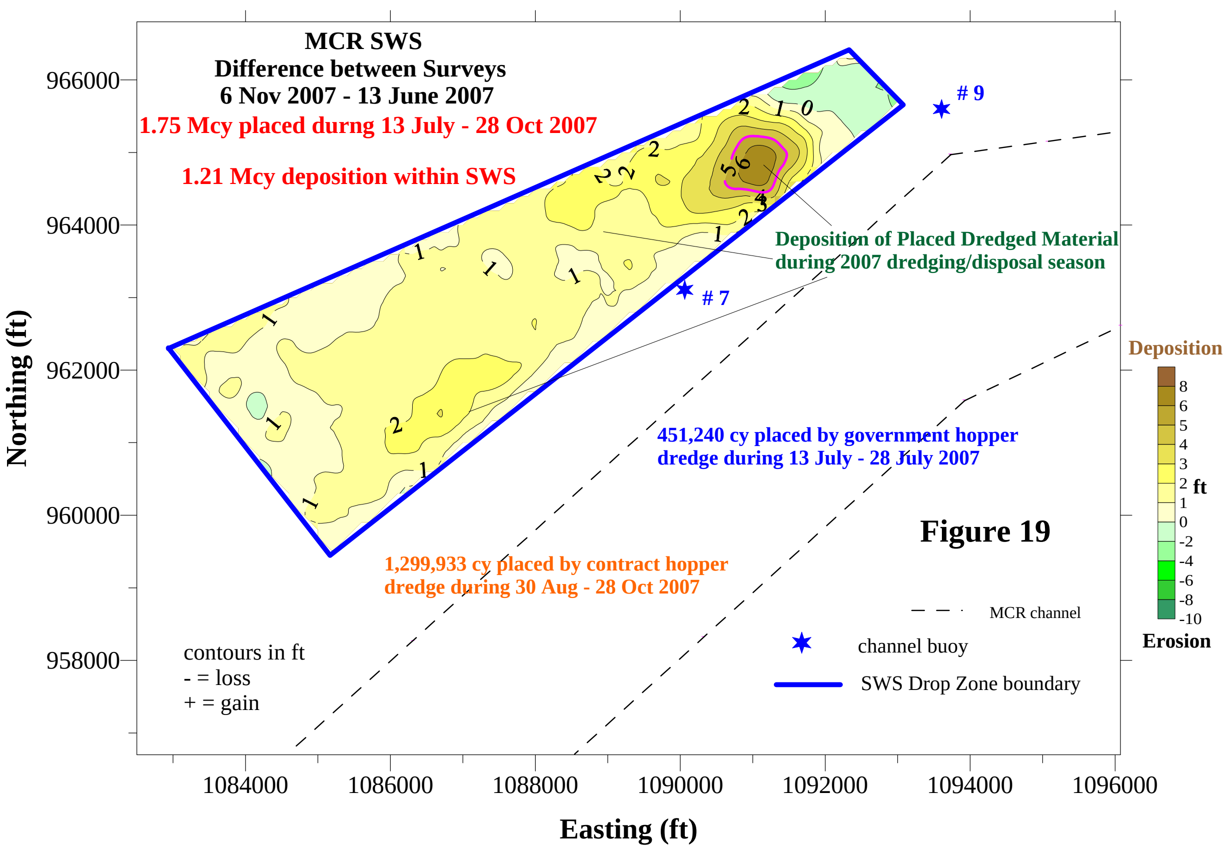
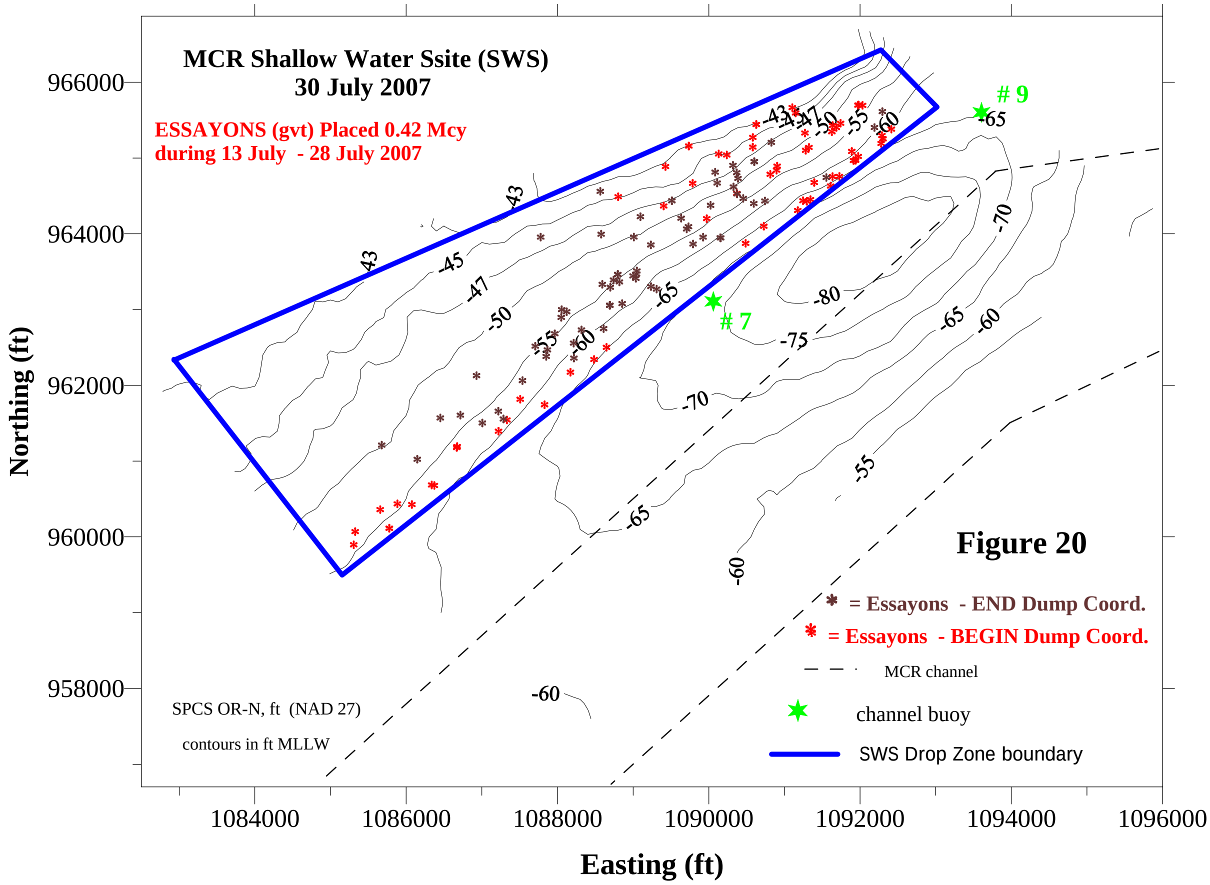
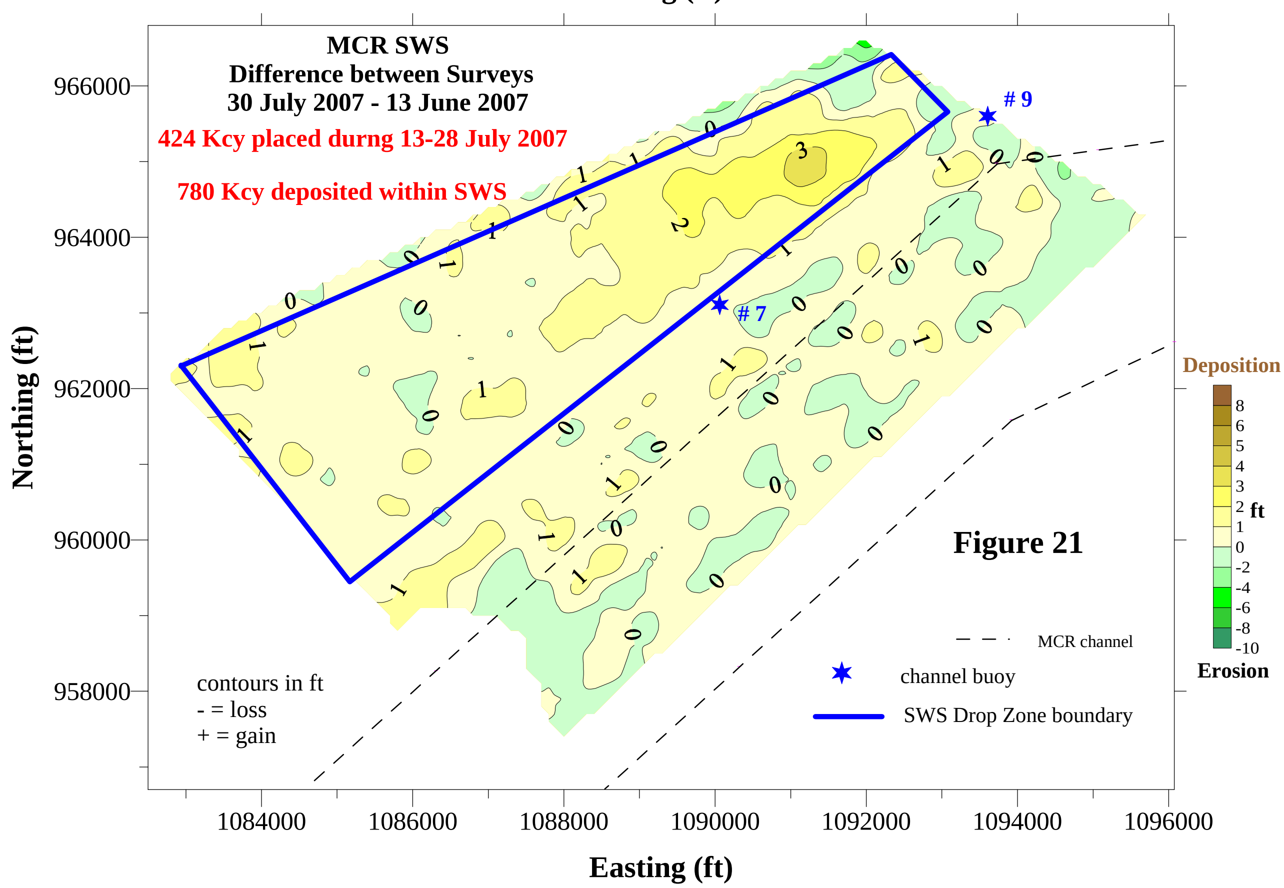
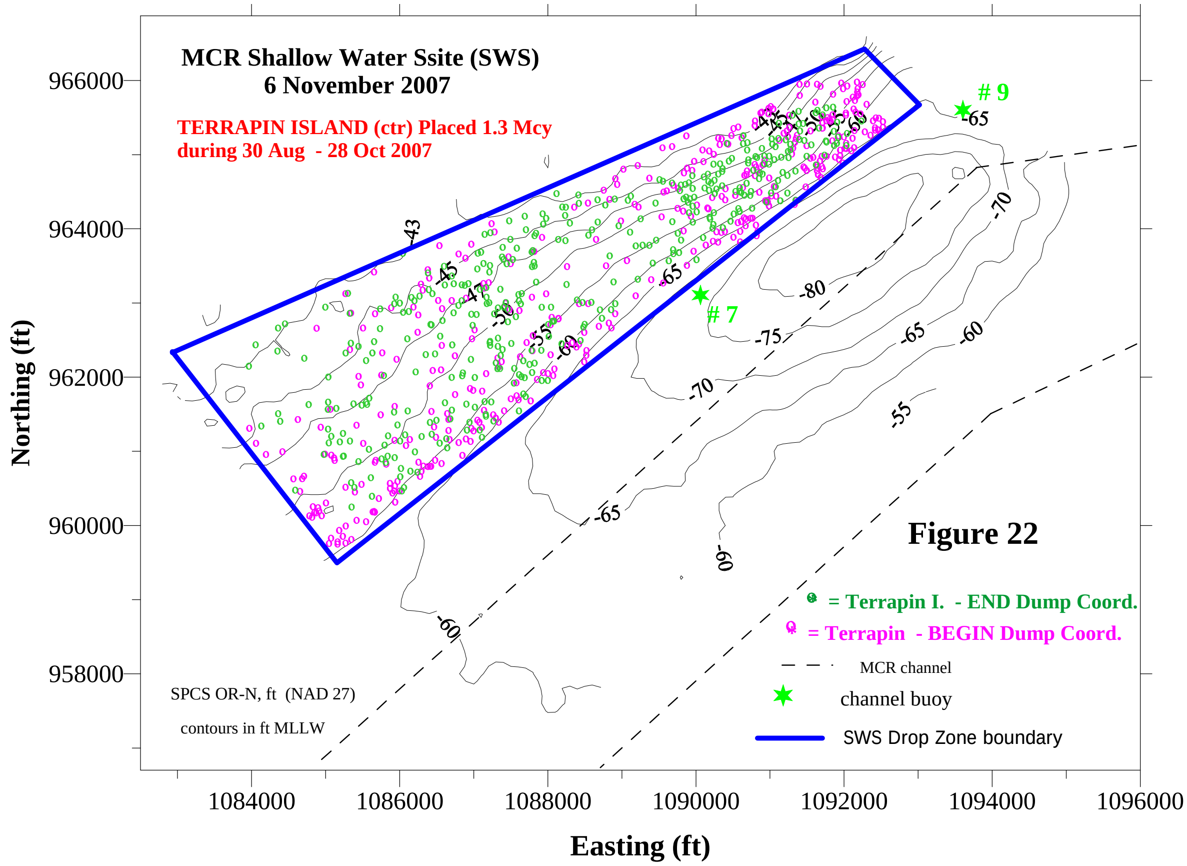
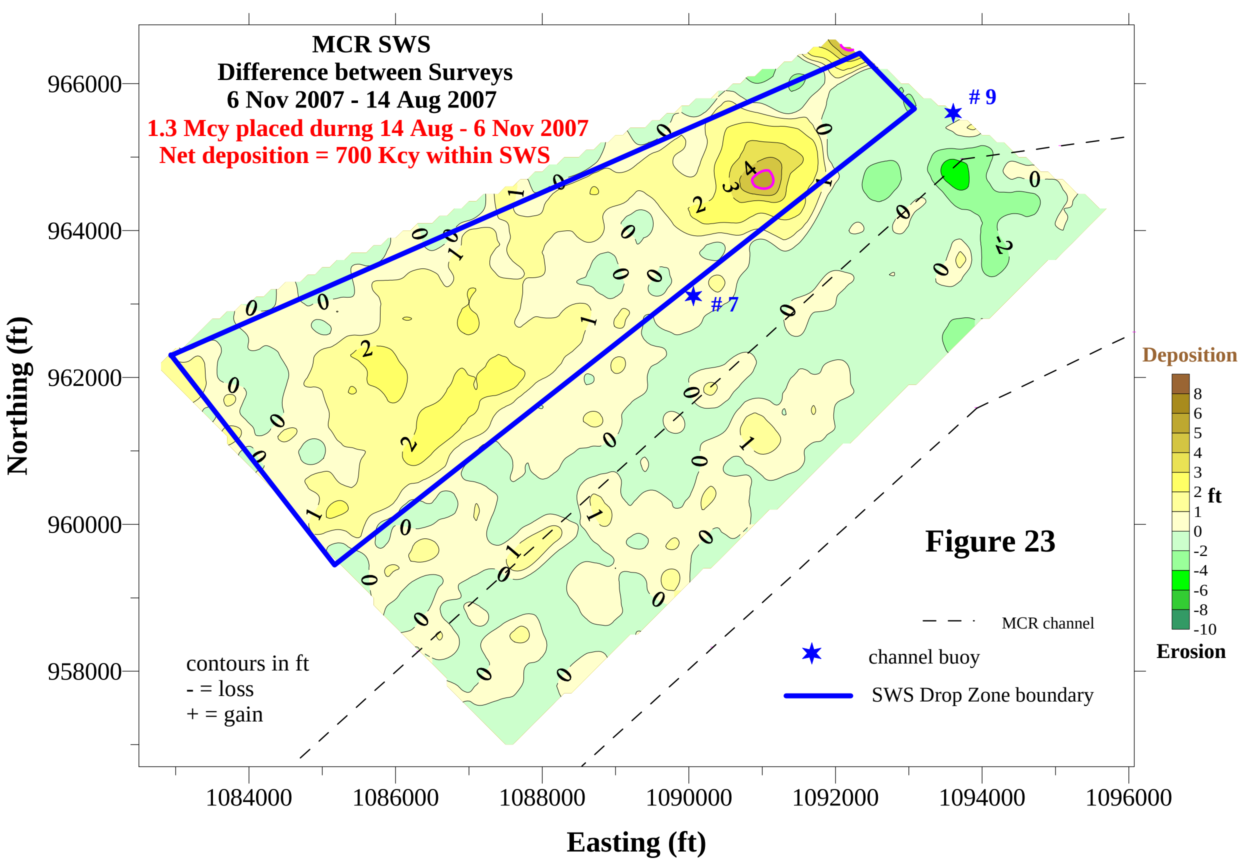


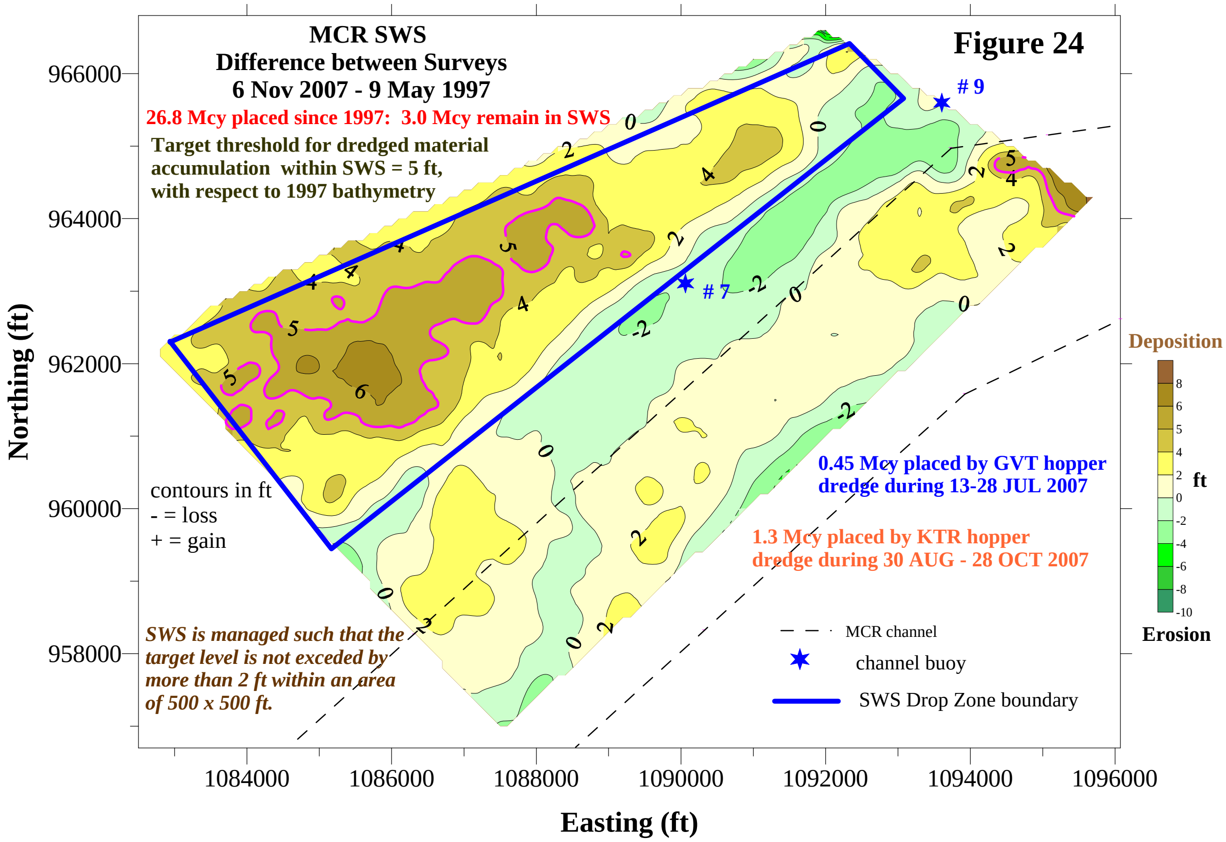
Figure 19

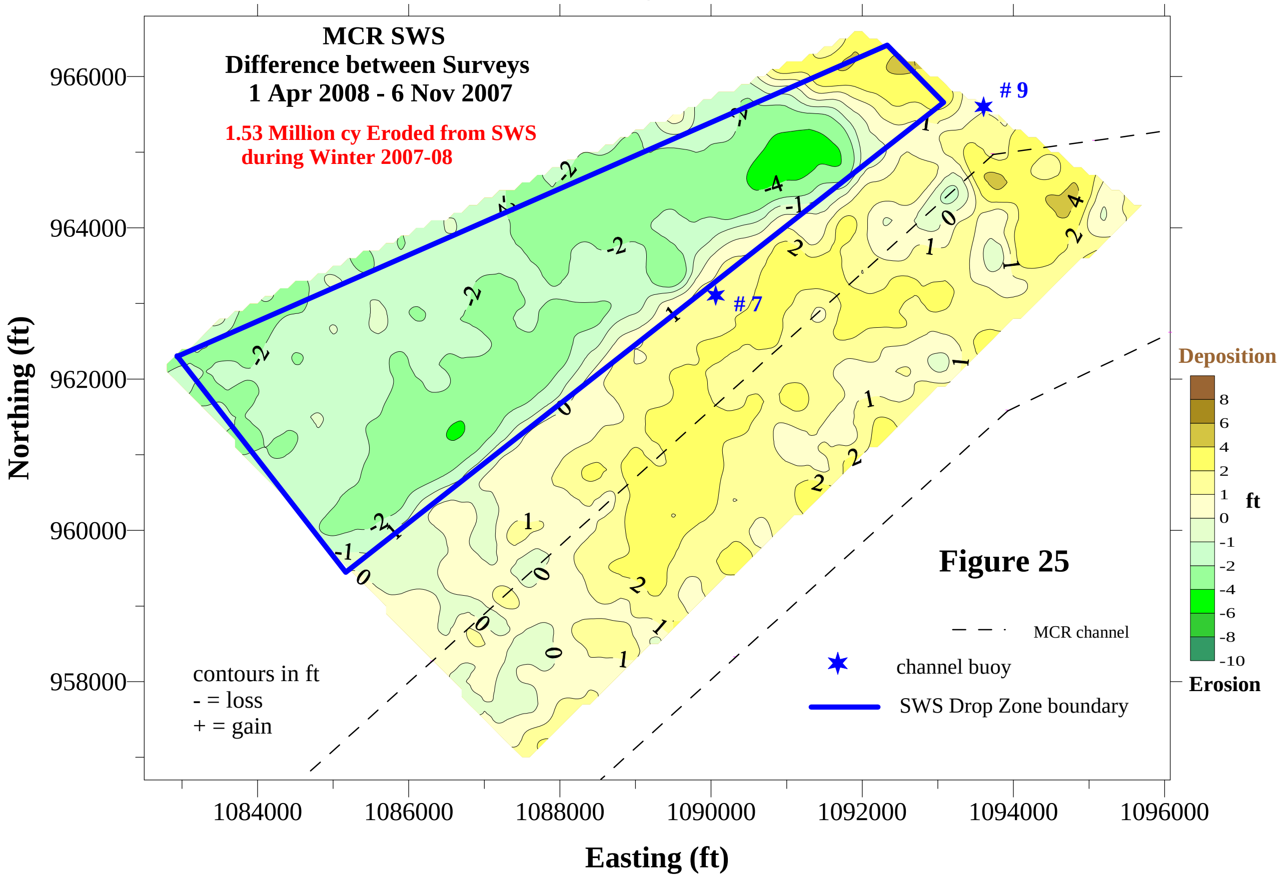

MCR Shallow Water Ssite (SWS)
30 July 2007
ESSAYONS (gvt) Placed 0.42 Mcy
during 13 July - 28 July 2007
Figure 20
= Essayons - END Dump Coord.
= Essayons - BEGIN Dump Coord.
MCR channel
channel buoy
SWS Drop Zone boundary
SPCS OR-N, ft (NAD 27)
contours in ft MLLW
9
7
Northing (ft)
Easting (ft)

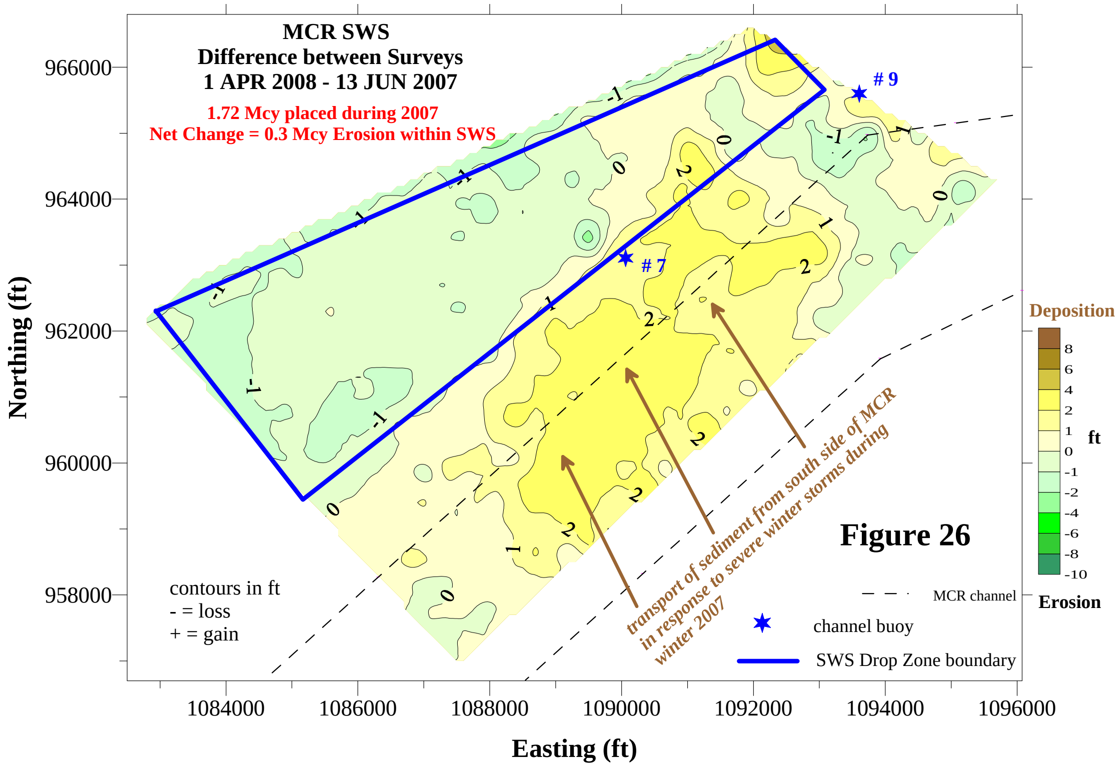

MCR SWS
Difference between Surveys
30 July 2007 - 13 June 2007
424 Kcy placed durng 13-28 July 2007
780 Kcy deposited within SWS
Figure 21
MCR channel
channel buoy
SWS Drop Zone boundary
contours in ft
- = loss
+ = gain
Deposition
ft
Erosion
9
7
Northing (ft)
Easting (ft)

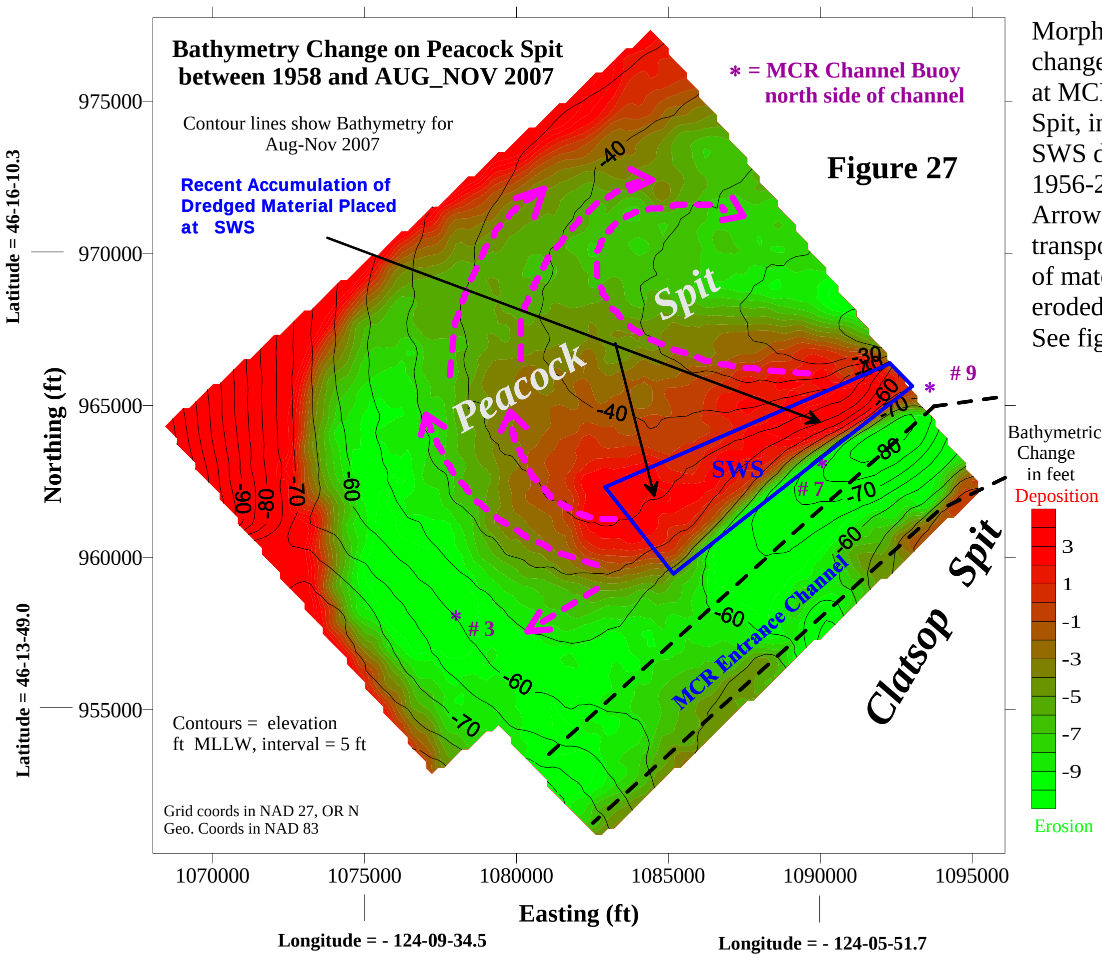

MCR Shallow Water Ssite (SWS)
6 November 2007
TERRAPIN ISLAND (ctr) Placed 1.3 Mcy
during 30 Aug - 28 Oct 2007
Figure 22
= Terrapin I. - END Dump Coord.
= Terrapin - BEGIN Dump Coord.
MCR channel
channel buoy
SWS Drop Zone boundary
SPCS OR-N, ft (NAD 27)
contours in ft MLLW
9
7
Northing (ft)
Easting (ft)


MCR SWS
Difference between Surveys
6 Nov 2007 - 14 Aug 2007
1.3 Mcy placed durng 14 Aug - 6 Nov 2007
Net deposition = 700 Kcy within SWS
Figure 23
Deposition
ft
Erosion
MCR channel
channel buoy
SWS Drop Zone boundary
contours in ft
- = loss
+ = gain
# 9
# 7
Northing (ft)
Easting (ft)


MCR SWS
Difference between Surveys
6 Nov 2007 - 9 May 1997
26.8 Mcy placed since 1997: 3.0 Mcy remain in SWS
Target threshold for dredged material accumulation within SWS = 5 ft, with respect to 1997 bathymetry
Figure 24
9
7
contours in ft
- = loss
+ = gain
0.45 Mcy placed by GVT hopper dredge during 13-28 JUL 2007
1.3 Mcy placed by KTR hopper dredge during 30 AUG - 28 OCT 2007
SWS is managed such that the target level is not exceded by more than 2 ft within an area of 500 x 500 ft.
MCR channel
channel buoy
SWS Drop Zone boundary
Deposition
Erosion
ft
Northing (ft)
Easting (ft)


MCR SWS
Difference between Surveys
1 Apr 2008 - 6 Nov 2007
1.53 Million cy Eroded from SWS during Winter 2007-08
9
7
Figure 25
contours in ft
- = loss
+ = gain
MCR channel
channel buoy
SWS Drop Zone boundary
Deposition
Erosion
ft
Northing (ft)
Easting (ft)

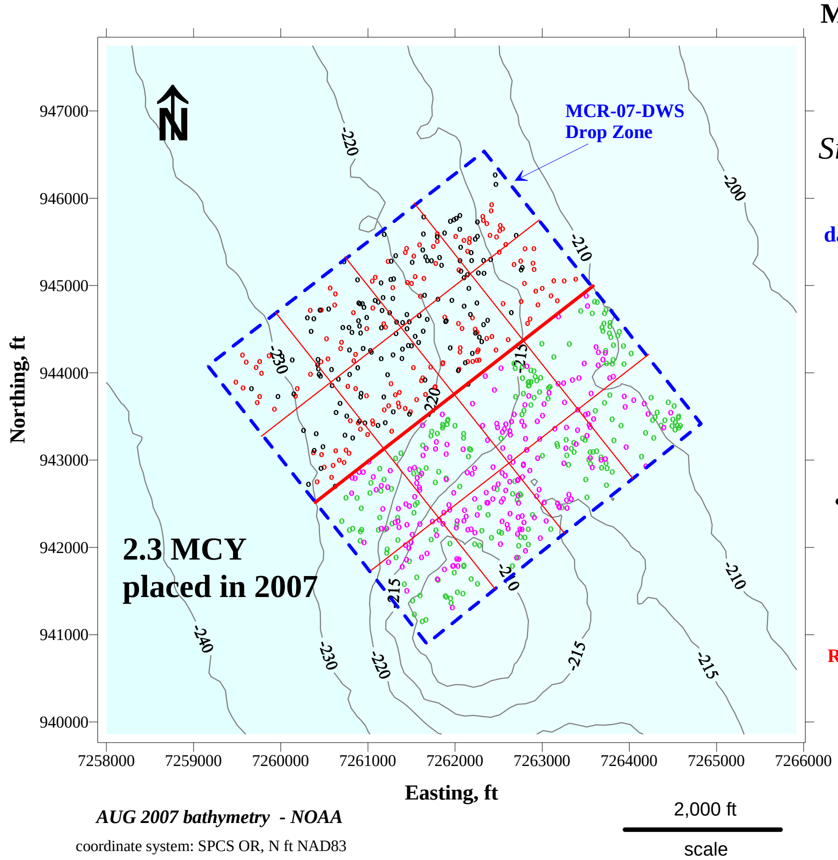




Morphology change observed at MCR Peacock Spit, including SWS during 1956-2007. Arrows indicate transport direction of material . eroded from SWS. See figure 43

Mouth of the Columbia River
Deep Water Site
(MCR-07-DWS)

Site Utilization During 2007



dashed blue line = "MCR-07-DWS"
Site drop zone is 4,000 x 4,000 ft

cells = 1,000 ft x 1,000 ft

• **= Beginning dump coord. - Essaysons**

• **= Ending dump coord. - Essaysons**

• **= Beginning dump coord. - Terrapin Island**

• **= Beginning dump coord. - Terrapin Island**

Figure 28

Red Lines = grid (cells) used to control the placement of dredged material within the MCR DWS area - 1,000 x 1,000 ft ea.

Mouth of the Columbia River
Deep Water Site
(MCR-07-DWS)

dashed blue line = "MCR-07-DWS"
Site drop zone is 4,000 x 4,000 ft

Red Lines = grid (cells) used to control the placement of dredged material within the MCR DWS area - 1,000 x 1,000 ft ea.

Difference Between Suveys
October 2000 - August 2007

Volume of dredged material placed within MCR-DWS-07 during 2007 = 2.3 million cy

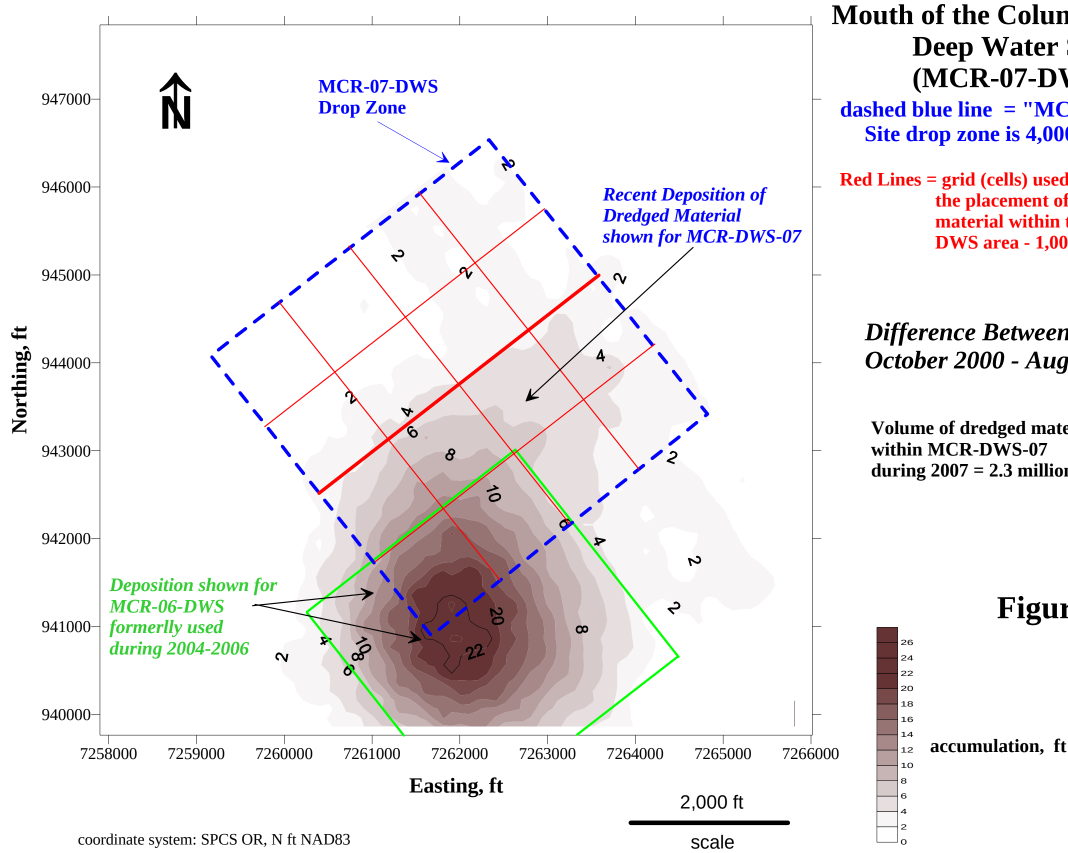


Figure 29

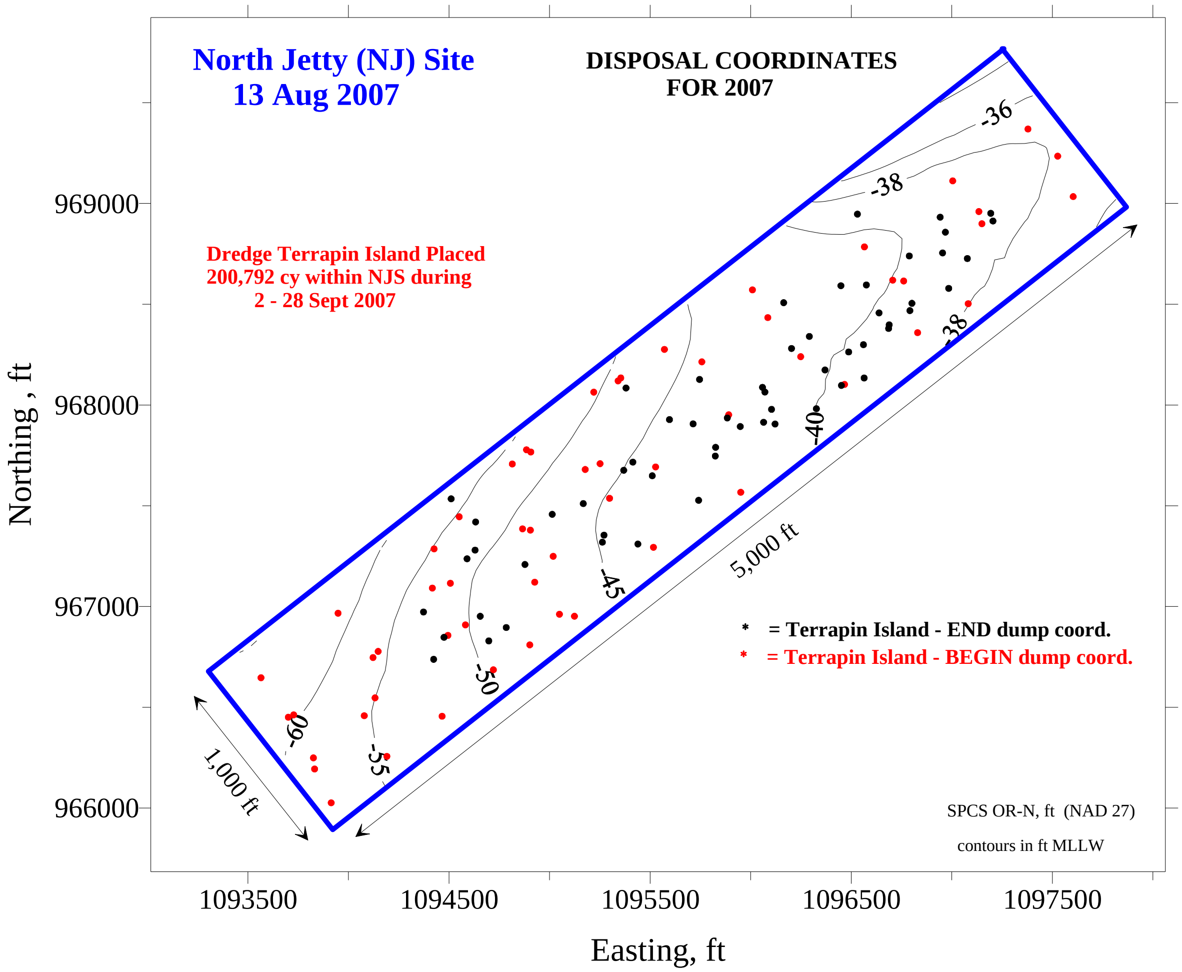

North Jetty (NJ) Site
13 Aug 2007
DISPOSAL COORDINATES
FOR 2007
Dredge Terrapin Island Placed
200,792 cy within NJS during
2 - 28 Sept 2007
* = Terrapin Island - END dump coord.
* = Terrapin Island - BEGIN dump coord.
SPCS OR-N, ft (NAD 27)
contours in ft MLLW
5,000 ft
1,000 ft
-36
-38
-40
-45
-50
-55
-60
969000
968000
967000
966000
1093500
1094500
1095500
1096500
1097500
Northing , ft
Easting, ft

Figure 30

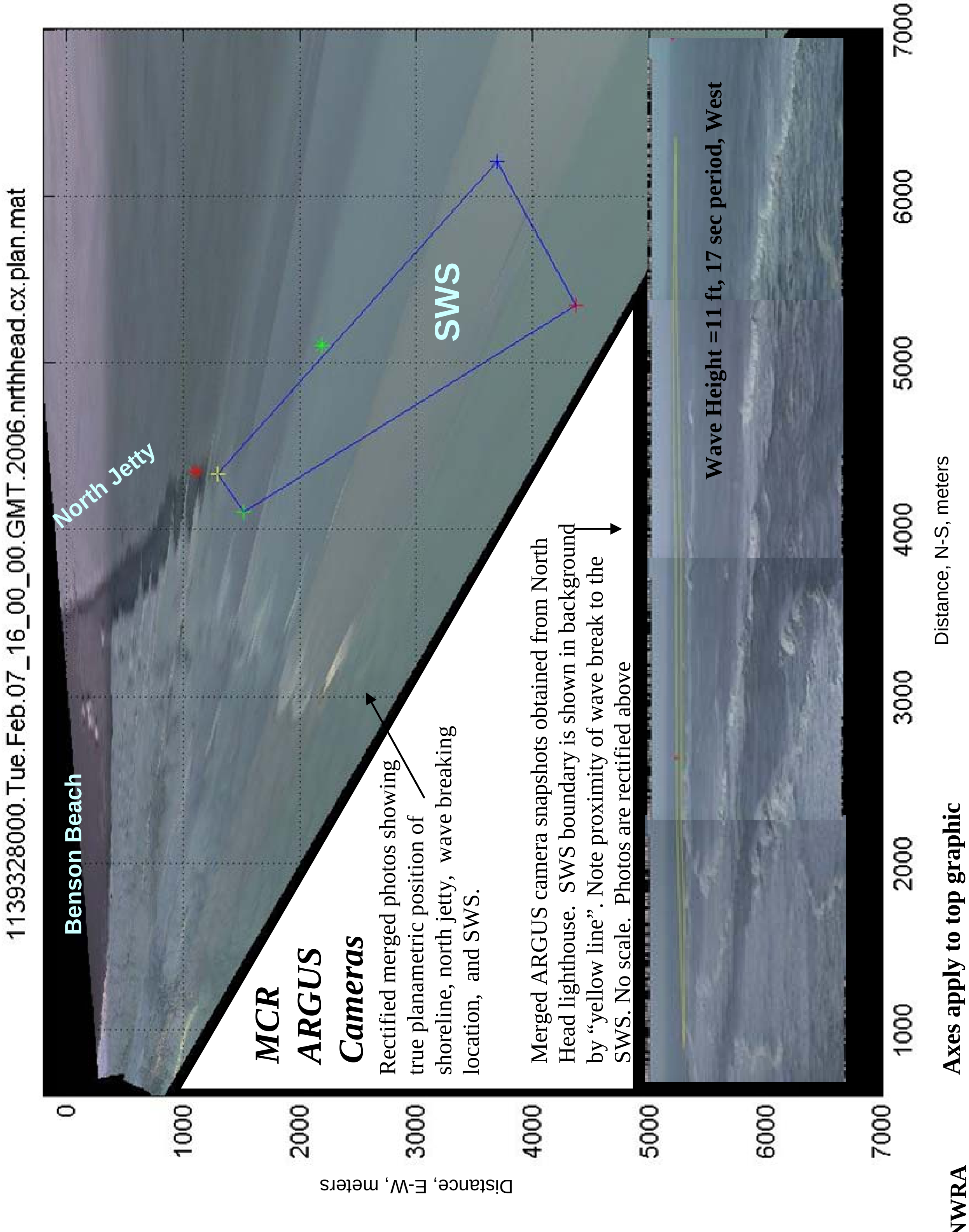
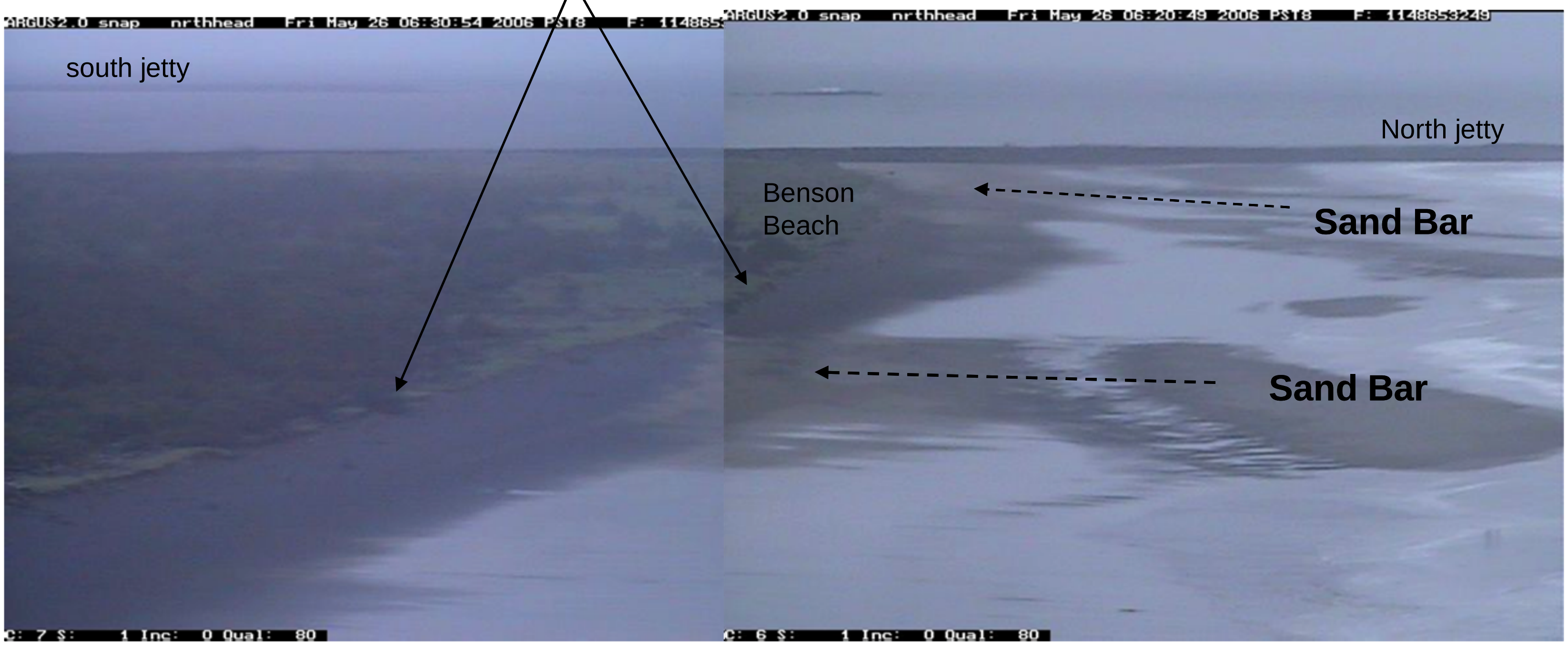

1139328000.Tue.Feb.07_16_00_00.GMT.2006.nrthhead.cx.plan.mat
Benson Beach
North Jetty
SWS
MCR ARGUS Cameras
Rectified merged photos showing true planametric position of shoreline, north jetty, wave breaking location, and SWS.
Merged ARGUS camera snapshots obtained from North Head lighthouse. SWS boundary is shown in background by "yellow line". Note proximity of wave break to the SWS. No scale. Photos are rectified above
Wave Height =11 ft, 17 sec period, West
Distance, E-W, meters
Distance, N-S, meters
Axes apply to top graphic
NWRA

Figure 31

26 MAY 2006 ARGUS Beach Monitoring System at North Head cameras 5 & 6

Additional Erosion (cutting) of Beach Scarp during winter '05-'06

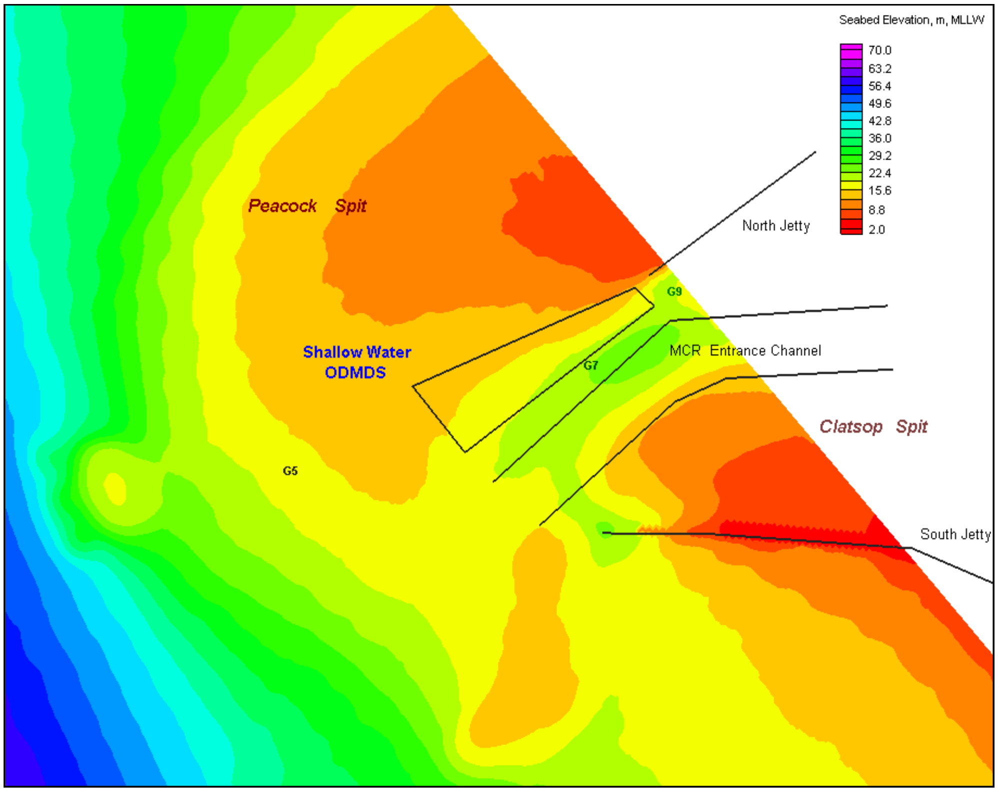


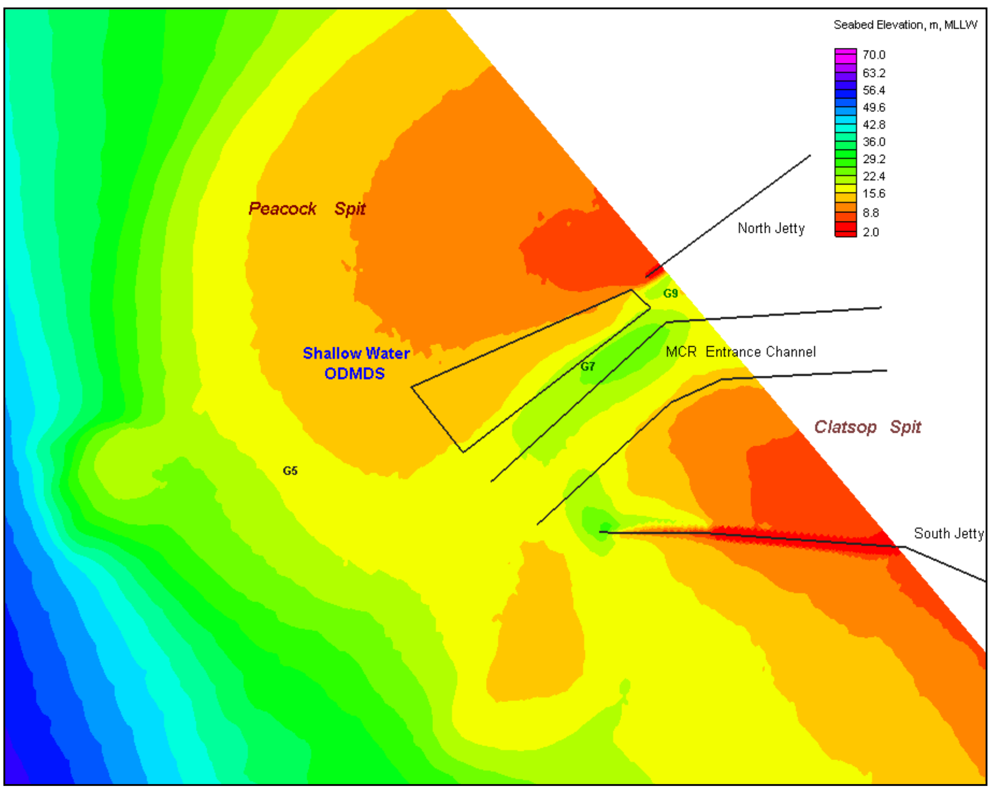
Sand from "Sand Bars" being transported onshore

Note lighter color of sand migrating shoreward from sand bars covering darker sands

The darker color sands contain hematite and other heavy minerals. The darker sands are more dense and less mobile than the lighter color sands, and tend to stay on the beach during the winter wave season. The dredged sediment placed at the SWS has likely contributed to the sand supply of Peacock Spit. The lighter color sands may have come from the dredged sand placed at the SWS.

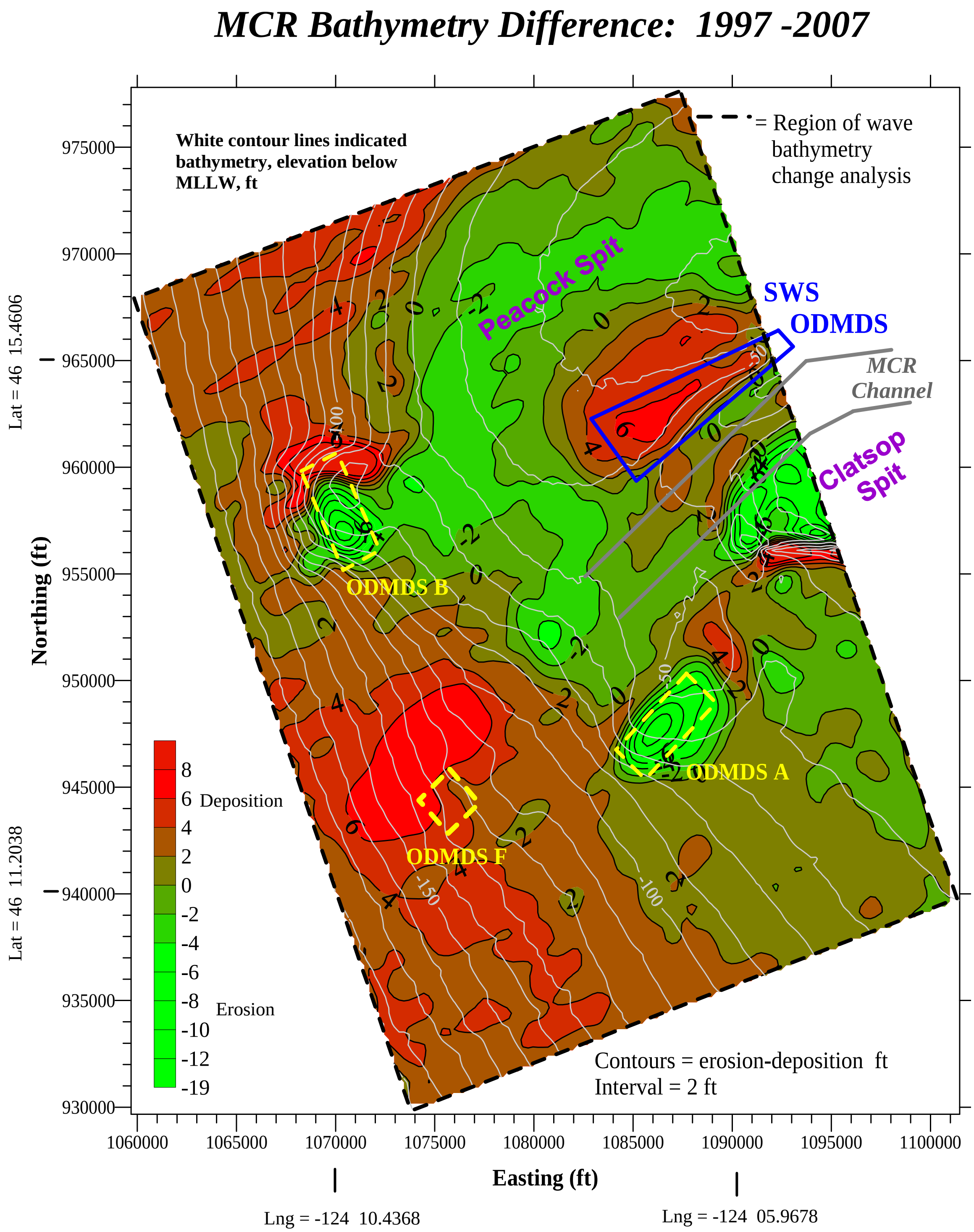
Figure 32





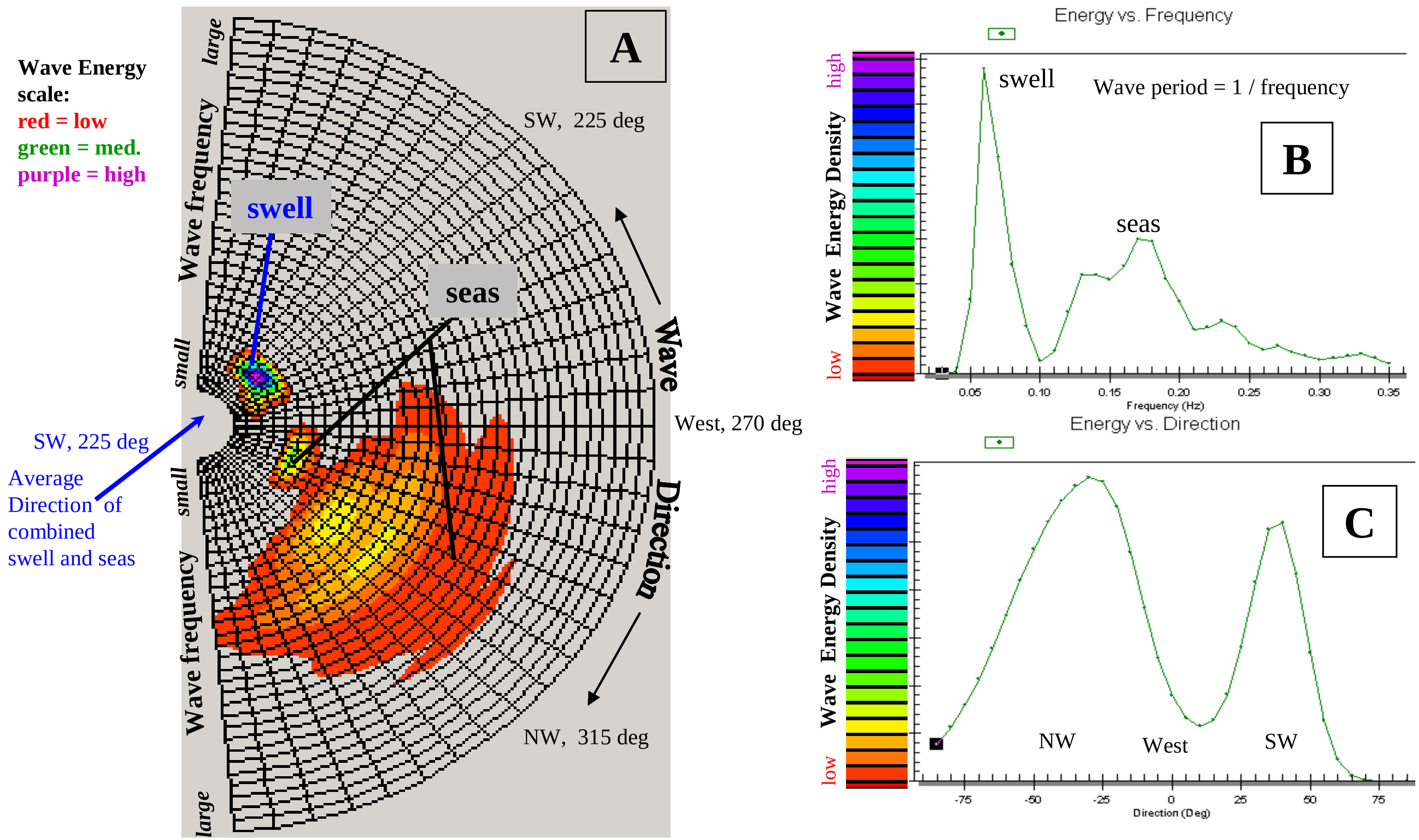
Bathymetry change at MCR during 1997 – 2007. Note that significant bathymetry change has occurred at areas beyond the effect dredged material placement operations (SWS ODMDS).

Figure 33



Bathymetry change is shown MCR during 1997 to 2007, highlighting large scale erosion of Clatsop Spit and Peacock Spit. Transport of dredged sediment placed at discontinued ODMDSs A, B, and F is also shown. Note how material had eroded from ODMDS A and Clatsop Spit is migrating toward the MCR channel. The placement of 25 MCY of dredged sand at the SWS has significantly abated erosion of Peacock Spit. Maintaining the morphology of Peacock Spit sustains the MCR inlet, North Jetty, and shorelands north of MCR. See Figure 43.

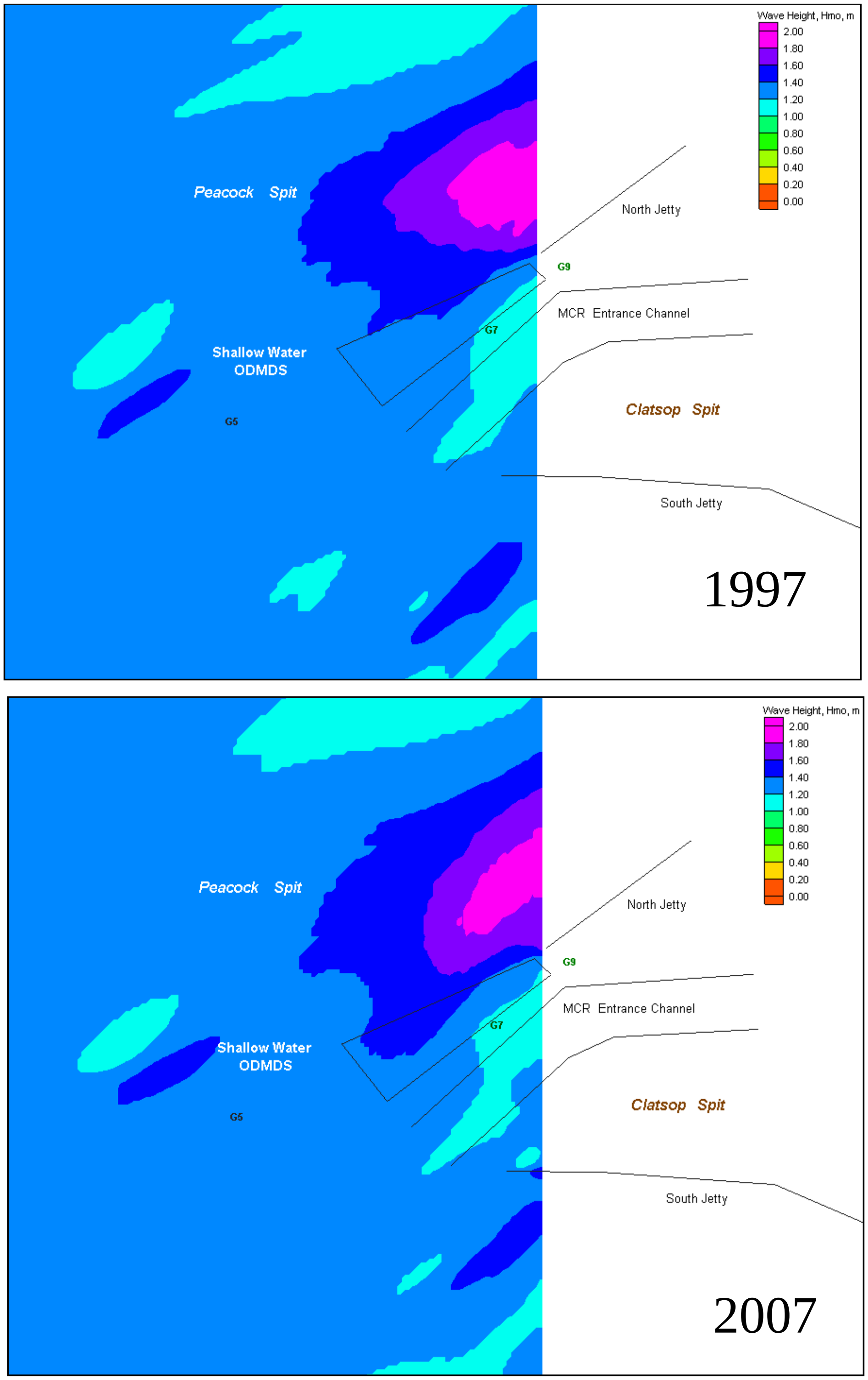
Figure 34



Summer Swell: Avg. wave height = 1.29 m, peak wave period=16.7 sec, Avg. Wave direction =SW (225 deg), Wind=5.4 m/s @ NW (316 deg)

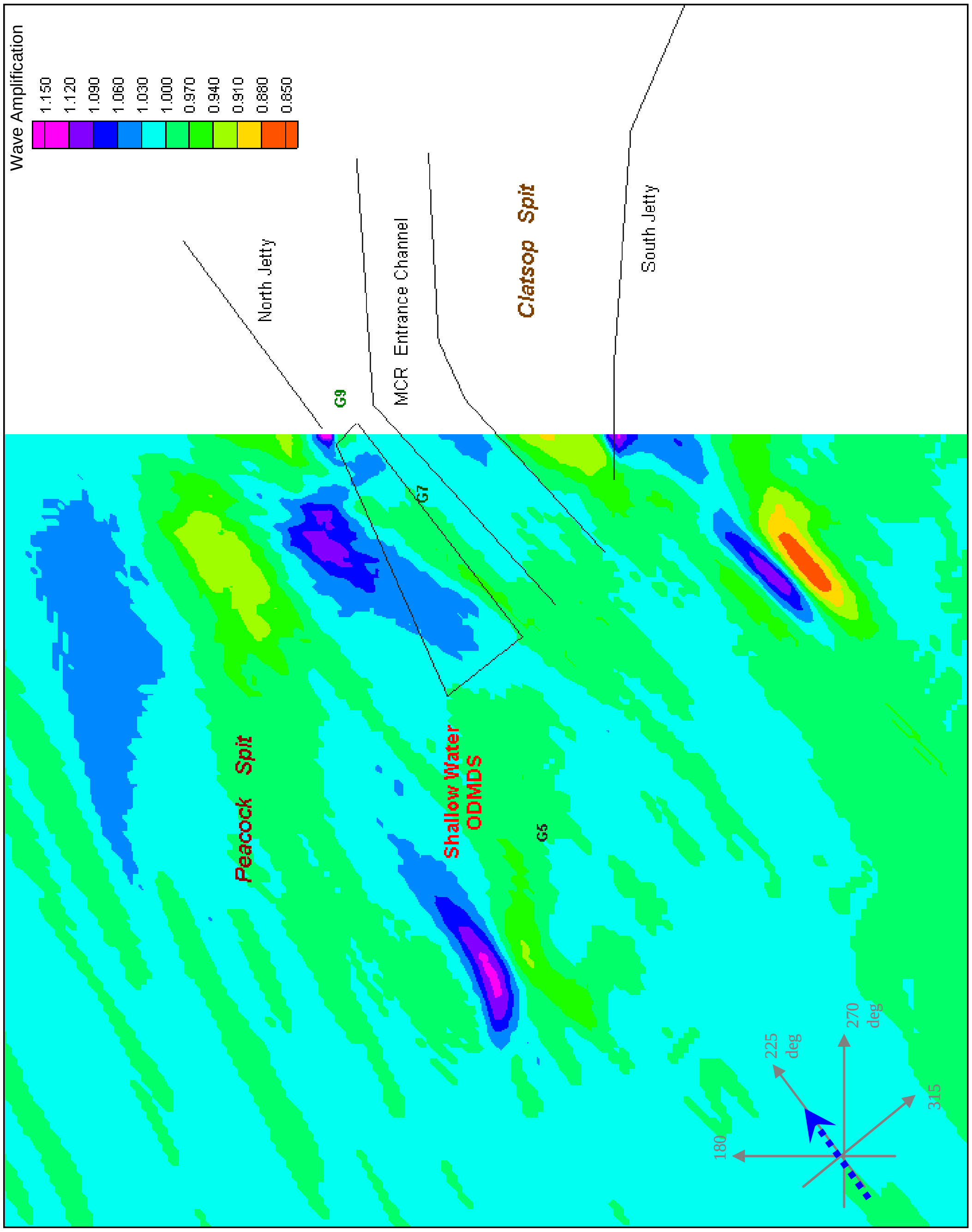
Energy spectrum for waves composed of swell and seas. Graphic (A) shows the wave energy distribution in terms of wave direction and frequency. Graphic (B) is a x-section thru the areas of maximum energy, along the frequency axis in (A), to show where the most energy is in terms of frequency . Graphic (C) is a x-section thru the areas of maximum energy, along the direction axis in (A), to show where the most energy is in terms of wave direction. The swell has a long period, is from one direction (SW), and distinctive from the seas; the seas include a wide range of frequency and direction; the wave field is a bi-modal combination of swell (distant source) and seas (local source).

Figure 35



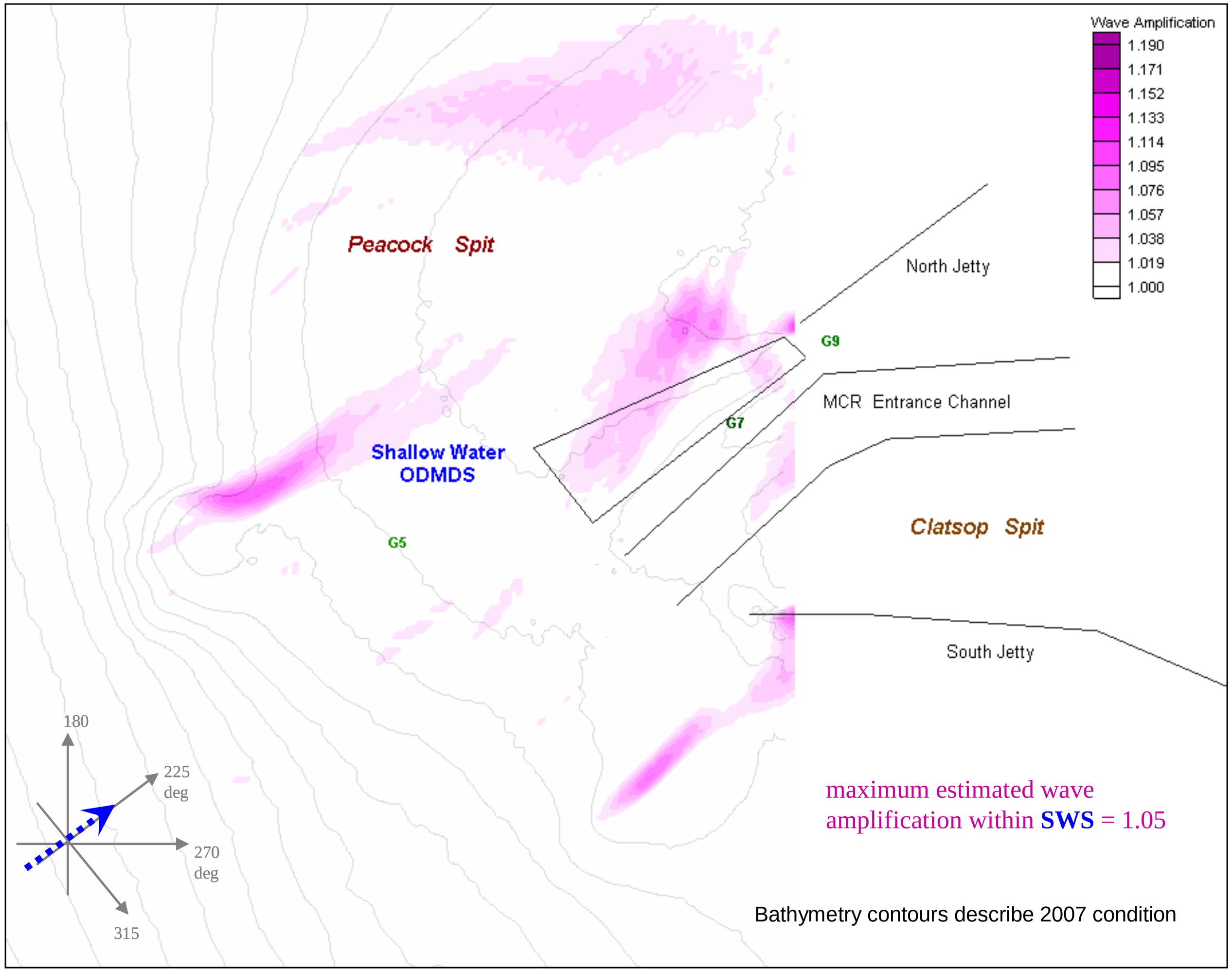
Summer Swell: Avg. wave height = 1.29 m, peak wave period=16.7 sec, Avg. Wave direction =SW (225 deg), Wind=5.4 m/s @ NW (316 deg)

Figure 36 STWAVE model simulation of nearshore wave height at MCR, for the prescribed offshore wave condition. Top graphic is for 1997 bathymetry, bottom graphic is for 2007 bathymetry.



Summer Swell: Avg. wave height = 1.29 m, peak wave period=16.7 sec, Avg. Wave direction =SW (225 deg), Wind=5.4 m/s @ NW (316 deg)

Figure 37. Estimated change in wave height at MCR due to 1997 – 2007 bathymetry change, for the prescribed offshore wave condition. "Wave amplification" was calculated as "2007 wave height / 1997 wave height. A value of 1.09 means that waves in 2007 were estimated to be 9% greater than in 1997.



Summer Swell: Avg. wave height = 1.29 m, peak wave period=16.7 sec, Avg. Wave direction =SW (225 deg), Wind=5.4 m/s @ NW (316 deg)

Figure 38. Estimated change in wave height at MCR due to 1997 – 2007 bathymetry change, for the prescribed offshore wave condition. "Wave amplification" was calculated as "2007 wave height / 1997 wave height. A value of 1.09 means that waves in 2007 were estimated to be 9% greater than in 1997. Values shown here are only for estimated wave height amplification greater than1.0.

Figure 39

1,200 Kg of sediment tracer material was mixed with sand (1:1) and released along the northern perimeter of the SWS during 1 October 2006. The tracer/sand mix was deployed on the seabed using 210-20 kg starch bags. Bags dissolved on seabed within 10 minutes.

Sediment tracer release locations (blue dots) where each 20 kg composited source was released on 1 OCT 2006

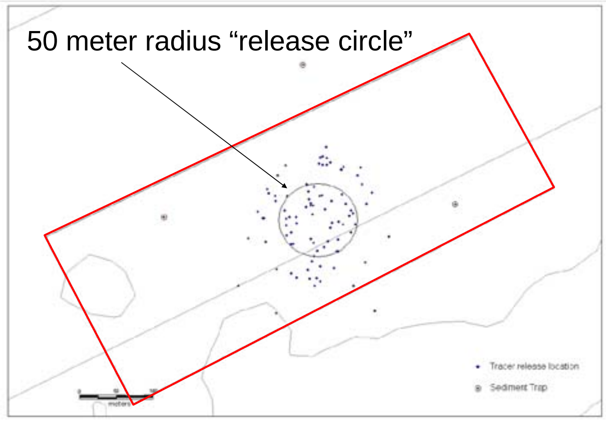
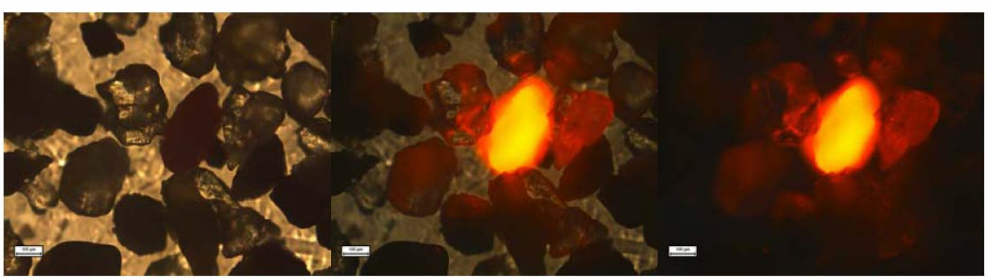


Figure 3.4: Map showing locations of sediment deployments relative to the main tracer release area and individual tracer placements.

Collection of sediment samples post-release. Post-release sediment sampling for tracer detection was performed at 4 general time periods (in days) after tracer release: 2 days, 60 days, 120 days, and 180 days.

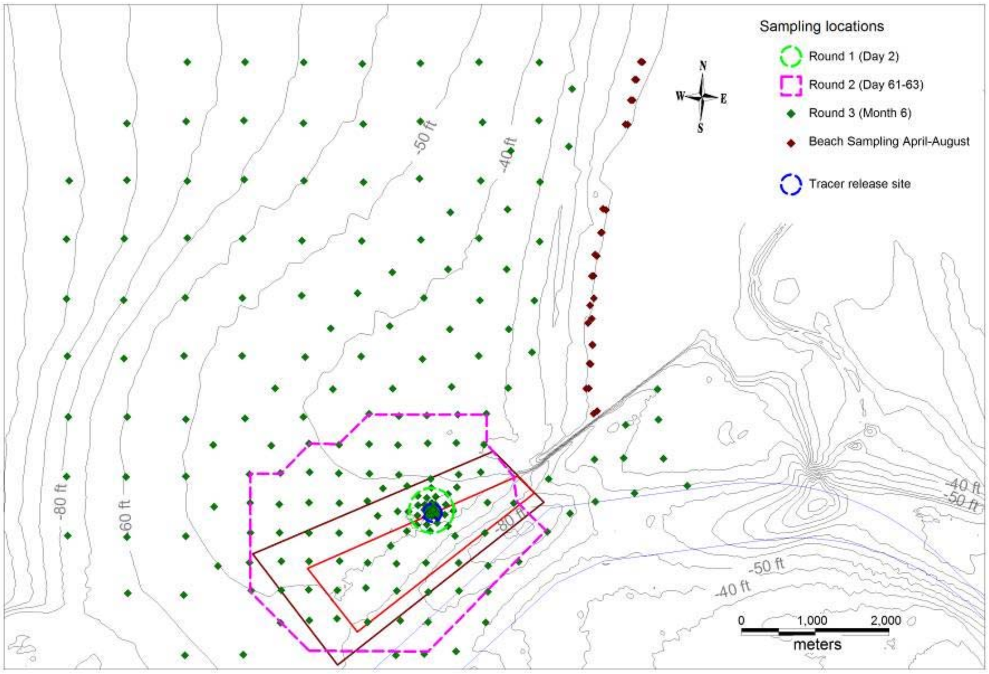


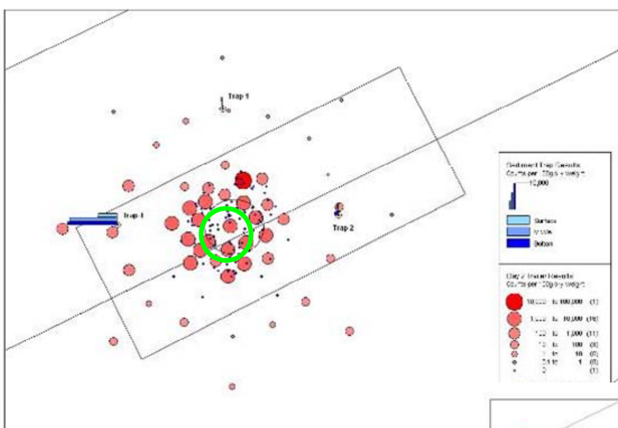
Tracer particle in native sand white light only, no fluorescence illumination.

Tracer particle in native sand White light and fluorescence illumination

Tracer particle in native sand No white light, fluorescence illumination only.

Figure 2.5: Fluorescence micrographs of an MCR tracer particle





Above graphic shows sediment sampling points to detect sediment tracer after tracer was placed on seabed on 1 October 2006.

Left-hand graphic shows tracer detection results 2-3 days after release. Green circle corresponds to tracer release site in figure 39.

Bottom graphic shows tracer detection results 60 days after release.

Note that the scale of detect tracer concentration between the upper graphic and right hand graphic is different. The concentration of tracer detected in the sediment samples on day 60 was 1/1000th of the concentration detected on day 2-3. This means that the tracer was being winnowed and transported away from the sediment at the drop zone. There is a likelihood that the sediment tracer was also being "worked" into the seabed by wave action and bedform activity.

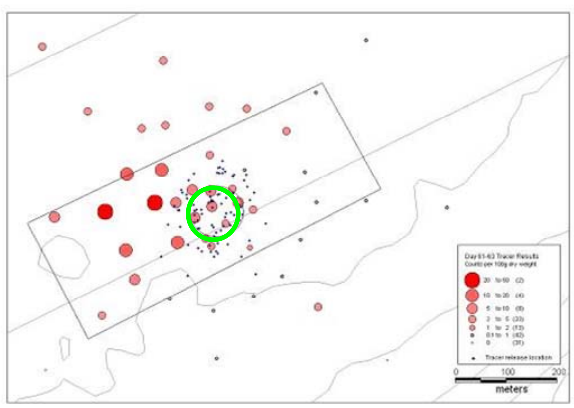


Figure 40

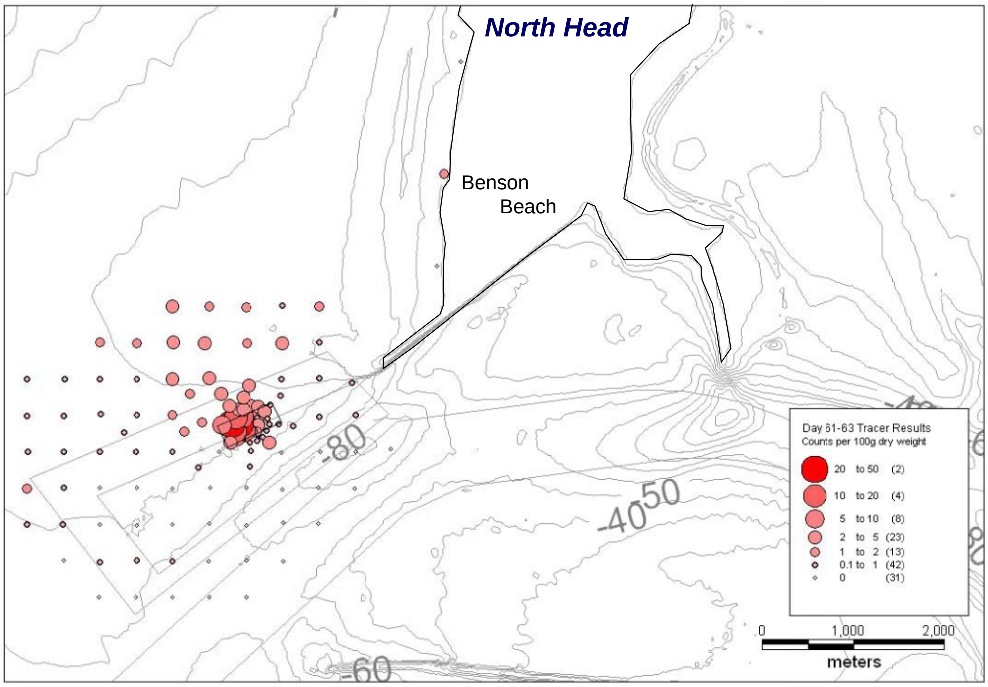


Figure 4.5: Tracer concentrations measured in grab samples collected Day 61–63 including Benson Beach

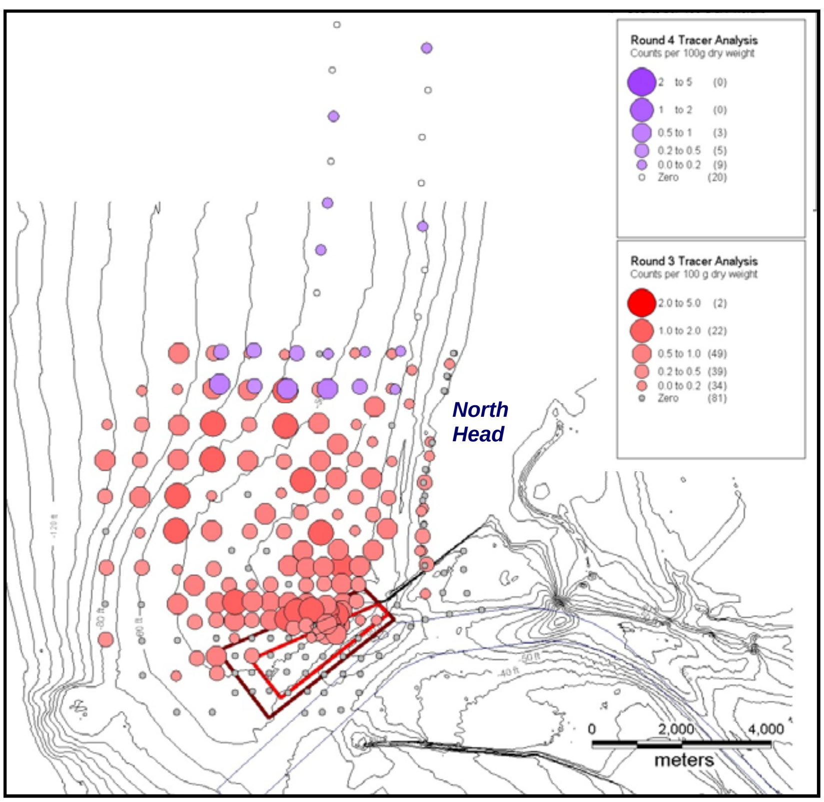


Figure 41

Top graphic shows sediment tracer detection results 62 days after release date (Oct 2006). Note detection on Peacock Spit and Benson Beach. SWS boundary shown by grey lines

Left-hand graphic shows tracer detection results 120 days after release (red) and 180 days after release date (purple). Note northward extent of tracer detection.

Note that the scale of detect tracer concentration between the upper graphic and right hand graphic is different. The concentration of tracer detected in the sediment samples on day 120 was 1/10th of the concentration

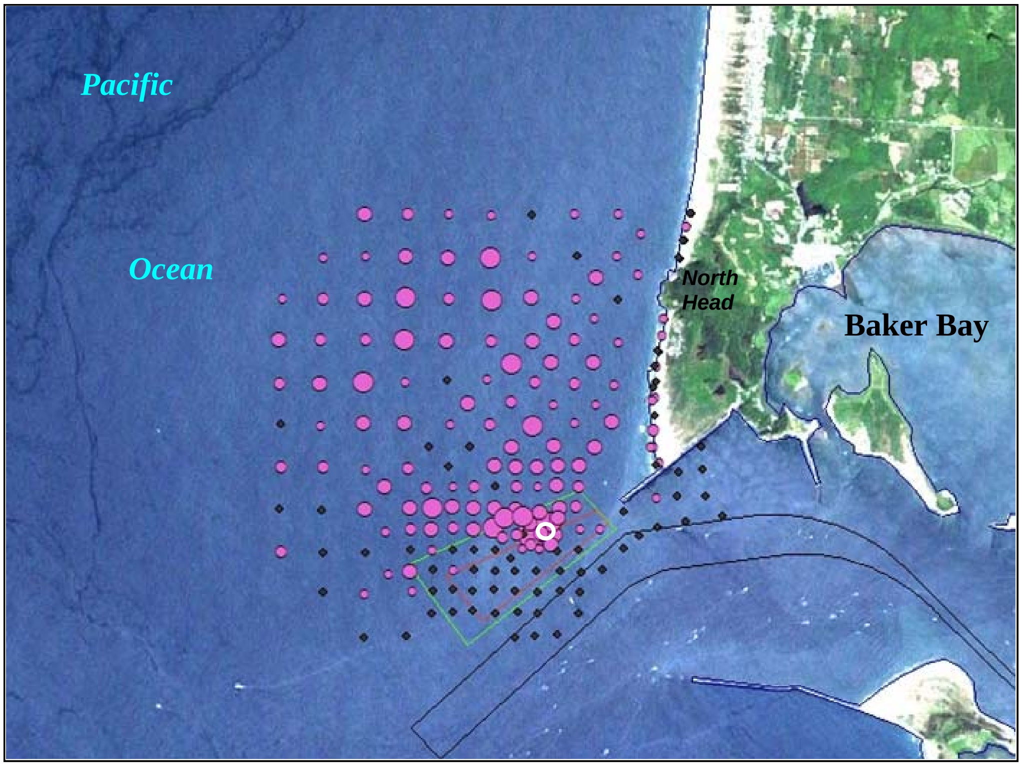


Figure 42a

Aerial image of MCR showing location of the navigation channel and SWS boundary. Sediment tracer results based on sediment sampling conducted during April-May 2007 are superimposed. The "white" circle denotes where the sediment tracer was release on 2-3 OCT 2006.

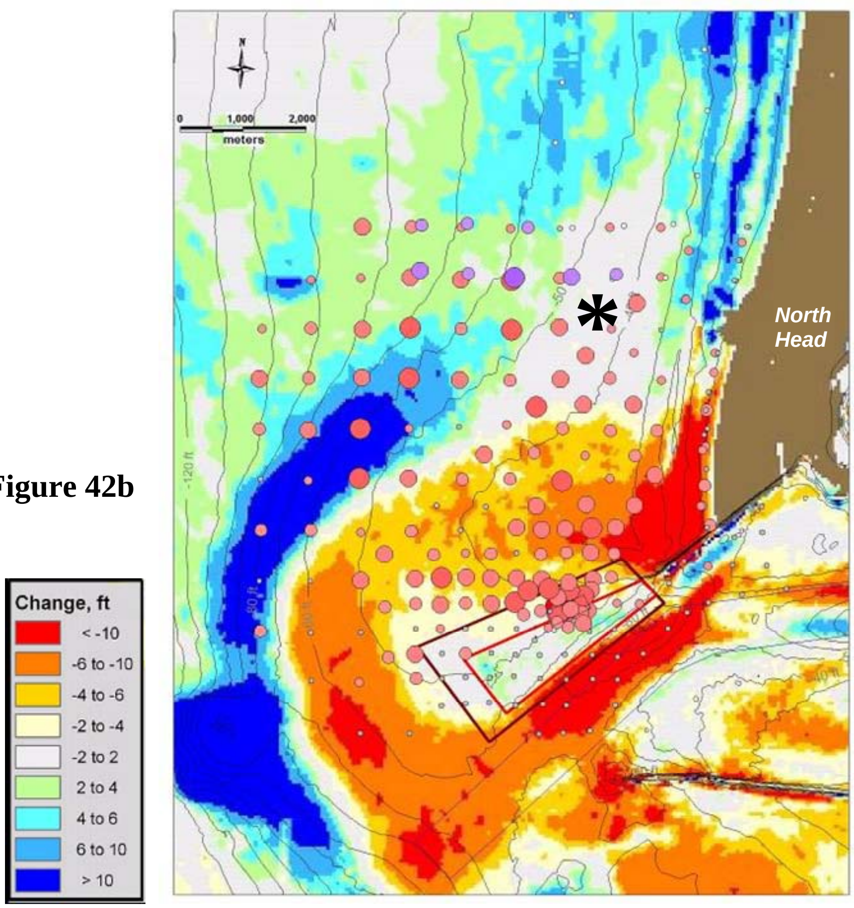
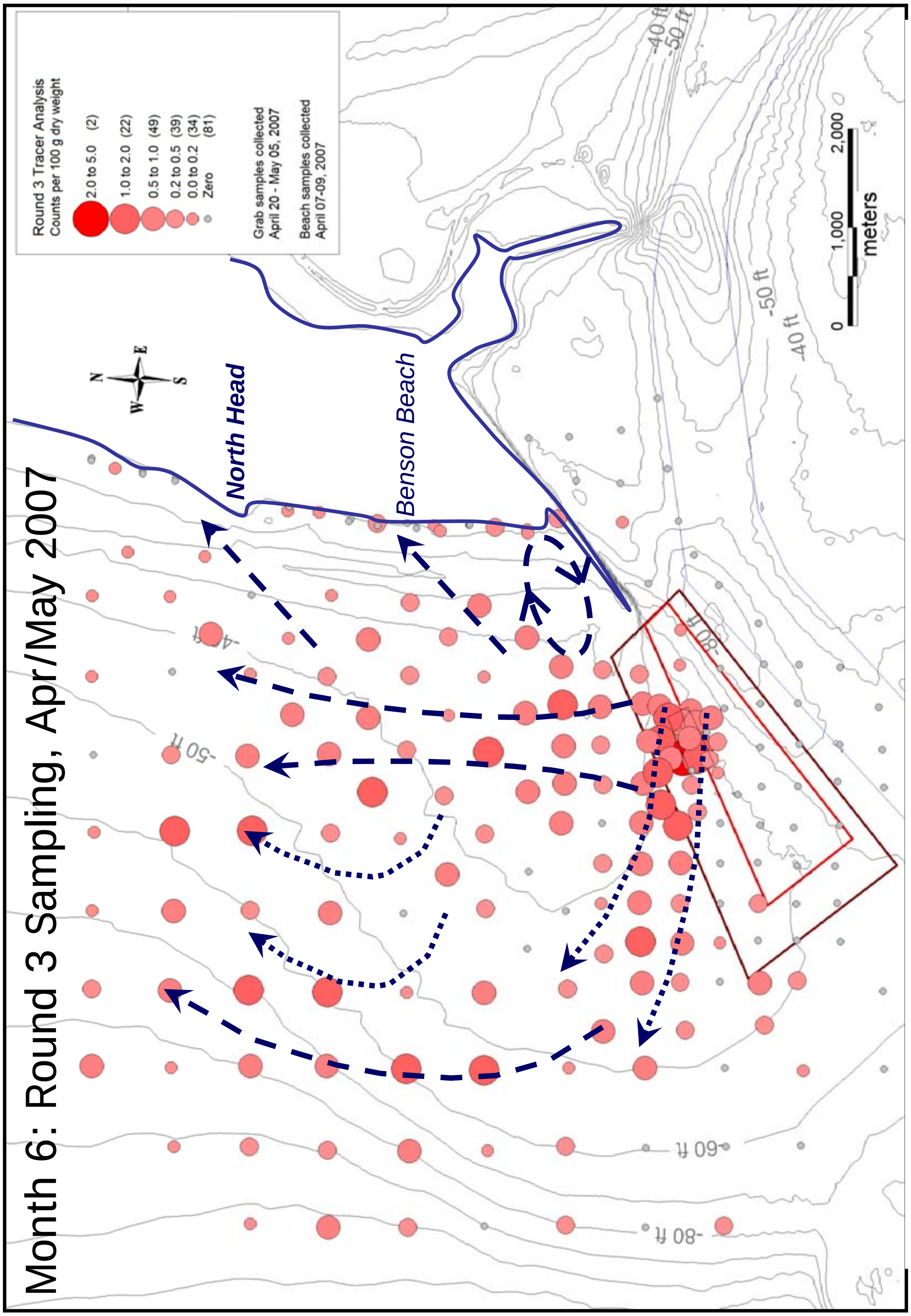


Figure 42b

MCR bathymetry change during 1958-2003, indicating the present day trend of bathy change. Reds indicate erosion, blue deposition. Sediment tracer results are superimposed to illustrate the potential pathways of sediment flux on Peacock Spit. The north side of MCR is dominated by bathymetry change on Peacock Spit. The nearshore area along Benson Beach has experienced significant erosion as manifest in fig 6. Excluding the SWS, the top of Peacock Spit has been eroding, with the eroded sediment being transported toward the West-North. Sediment transported to the seaward base of Peacock Spit is being fluxed along the base of the spit toward the nearshore of WA. The area marked by (*) is believed to have large quantities of sediment fluxed over the seabed as the material is transported northward from Peacock Spit.



Inferred sediment transport pathways on Peacock Spit based on sediment tracer experiment conducted during Oct 2007 – May 2007 and observation of bathymetry change during 1997 -2007 and 1958-2007.

Figure 43